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Compressed Air Magazine

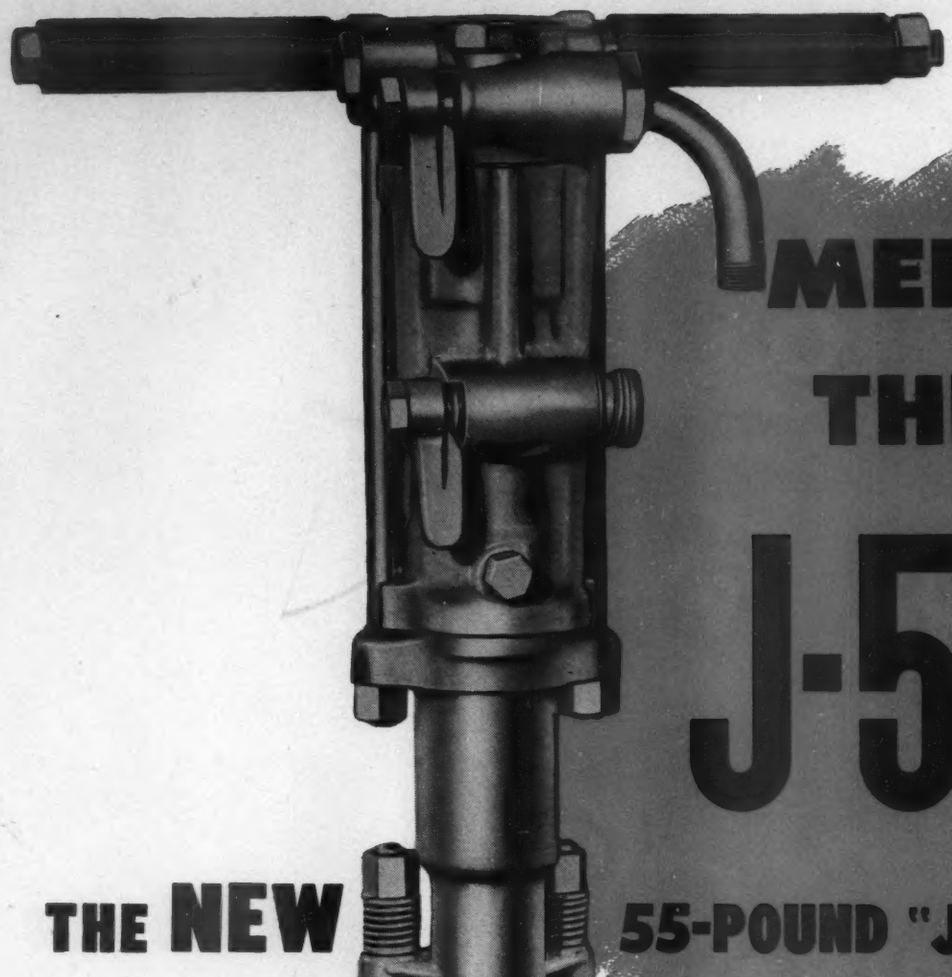
SEPTEMBER 1946

SPLITTING SLATE IN FRENCH SHOP

Use of modern mechanical aids enables women to do much of the dressing work

(See article page 237)

VOLUME 51 • NUMBER 9 NEW YORK • LONDON



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ON THE COVER

NOT so long ago, slate was split in France by men who used their feet and lower legs as vises to hold the stone, as illustrated on page 241. With the introduction of clamps, operated by a foot pedal and mounted on a table at convenient working height, the operation became easy enough for women to perform. In similar manner, other simple tools and fixtures have been devised to permit the employment of numerous women and thus the industry has carried on during the war years in the face of declining man power.

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IN THIS ISSUE

YELLOWKNIFE, in the District of Mackenzie, may have the makings of one of Canada's leading gold-mining camps. Activity that waned during the war period has reached a new high during the past year and scores of exploration parties are examining mineral showings over a wide area. The discovery of large hitherto unsuspected ore bodies on claims of Giant Yellowknife Gold Mines insures one large producer and has quickened the search for similar deposits. The mineralized zone on Giant property alone is as long as the entire Kirkland Lake District in Ontario, which contains several of Canada's leading gold mines. Our first article tells something of Yellowknife's past and present and speculates on its future. Acknowledgment is made to Standard Oil Company (N. J.) for the photographic illustrations.

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IN MOST parts of the world, slate is quarried, but in France it is mined. Experience gained through the centuries and the addition of machinery have combined to evolve a highly efficient system that enables the industry to carry on in spite of numerous obstacles. Past and present methods of extracting and dressing the stone are described in an article beginning on page 237. It was written by S. Gradel, who has been associated with the industry for 35 years. Mr. Gradel's description applies primarily to the operations of the Societe des Ardoisieres d'Angers, which is the largest of the several companies that produce slate in the Angers Basin. Accompanying photographs are reproduced through the courtesy of the same concern.

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THE many contributions compressed air makes to the manufacture of bimetal brake linings by S. K. Wellman Company are described in a short article starting on page 244. Acknowledgment is made to the Compressed Air Institute for data and photographs.

Compressed Air Magazine

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C. H. VIVIAN, *Editor* J. W. YOUNG, *Director of Advertising*
ANNA M. HOFFMANN, *Assistant Editor* J. J. KATARBA, *Advertising Mgr.*
D. Y. MARSHALL, *Europe*, 243 Upper Thames St., London, E.C.4.
F. A. MCLEAN, *Canada*, New Birks Building, Montreal, Quebec.

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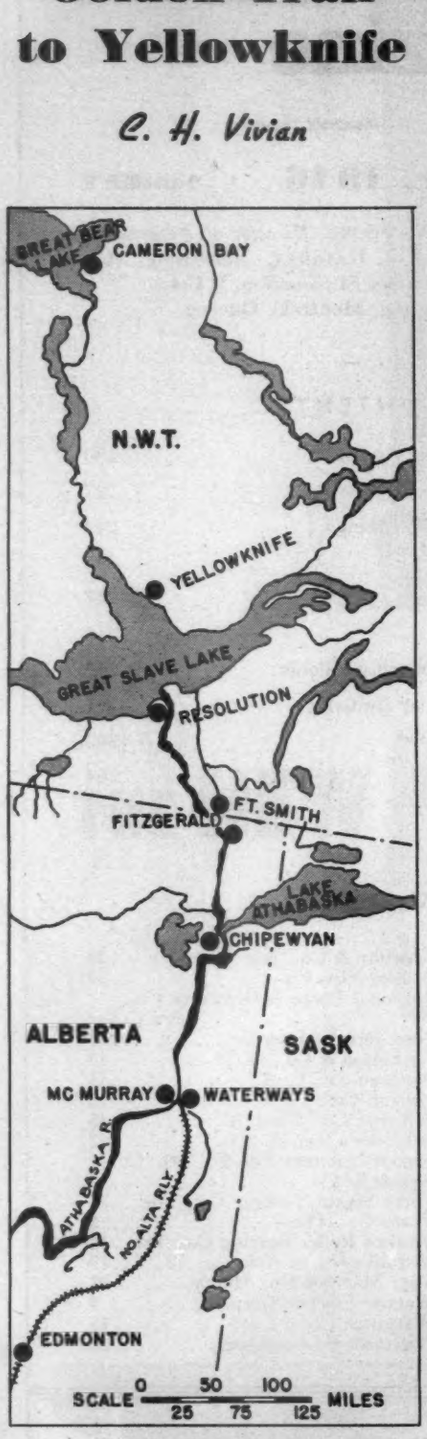
The Golden Trail to Yellowknife

C. H. Vivian



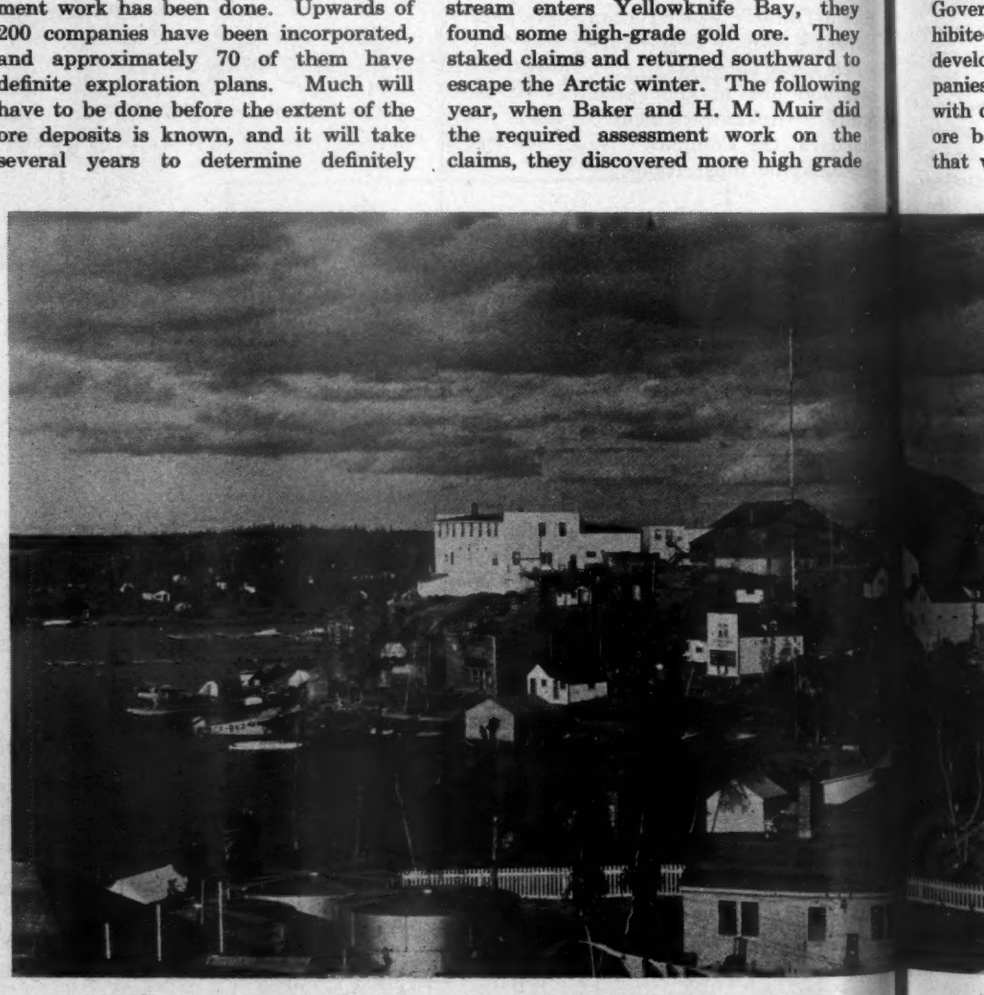
THE WATER ROUTE
From the end of steel at Fort McMurray, barges go down the Athabaska and Slave River systems to Great Slave Lake, but freight must be unloaded and portaged 16 miles between Fitzgerald and Fort Smith. It is an 8-day trip. This route is open only about three months of the year, but airplanes make the flight to Yellowknife in a few hours at all seasons. A new all-year highway is now being built from Grimshaw, Alta., to Yellowknife.

HISTORY shows that the quest of gold has been a great colonizer. There have always been men that were willing to leave their hearths to take up the auriferous trail, and neither torrid deserts nor frigid heights have held any terrors for them. Whenever they have found what they went for, others have been quick to follow, and thus civilization has tagged along behind the pick and the gold pan. Men have not changed much with the passing years, and even though the extension of frontiers has narrowed the orbits of their operations there are still outposts to challenge those that are restless and hardy.

Up in the Canadian Northland, nearly 500 miles from the nearest railroad and only 250 miles below the Arctic Circle where winter holds the land in its icy embrace for two-thirds of the year, the gold-mining community of Yellowknife is being established. It is not strictly a new camp, but even gold rushes have to wait for wars to be won and lost. Prospectors made the first strikes there more than ten years ago and a sizable mining industry grew up, but the conflict drew away its manpower and it had to close down. Now there is renewed activity on a bigger scale than before. Last year alone 9481 claims were recorded, and today there are more than 15,000 on which the required assessment work has been done. Upwards of 200 companies have been incorporated, and approximately 70 of them have definite exploration plans. Much will have to be done before the extent of the ore deposits is known, and it will take several years to determine definitely whether Yellowknife will fulfill the optimistic predictions that have been made for it.

Yellowknife, which is said to have been so named because the Indians of the area carried knives having yellow handles, lies on the west side of a narrow bay that deeply indents the northern shore of Great Slave Lake in Northwest Territories. It is 710 air miles north of Edmonton, Alta. The first evidences of mineralization in the section were samples of zinc blende picked up in 1897 by a man named Blakeney while traveling overland from Alaska to Ottawa. The ore was later found to contain gold, but because of the remoteness of the district no effort to prospect it was made for more than 30 years.

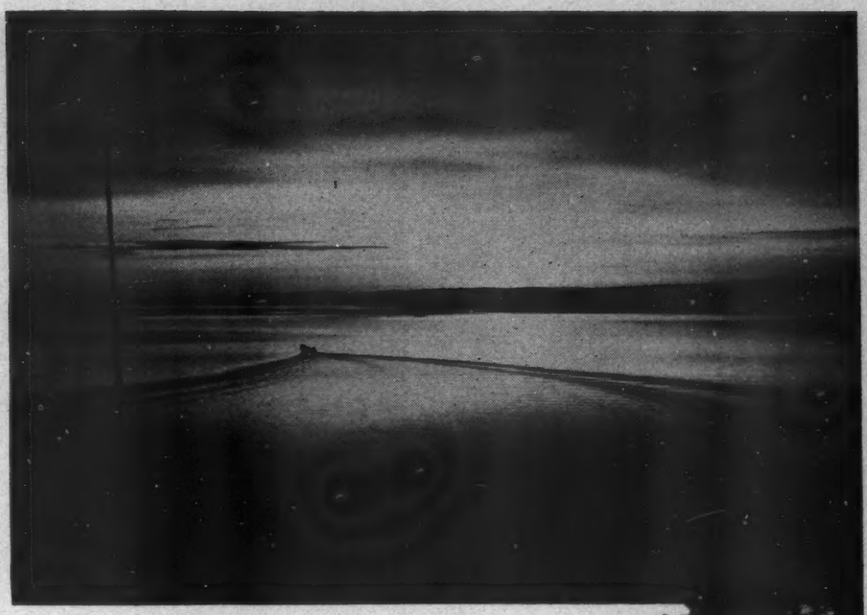
In 1930, Gilbert Labine discovered pitchblende at Great Bear Lake, 250 miles farther north, and developed a radium mine that has become one of the world's leading sources of that precious metal. Other companies were organized to search for radium, and among them was the Bear Exploration & Radium Company, Ltd. (B.E.A.R.) In 1933, it sent C. J. Baker and Herbert Dickson to prospect the area around Great Slave Lake. They explored the headwaters of the Yellowknife River in a canoe and, at Quyta Lake, 25 or 30 miles from where the stream enters Yellowknife Bay, they found some high-grade gold ore. They staked claims and returned southward to escape the Arctic winter. The following year, when Baker and H. M. Muir did the required assessment work on the claims, they discovered more high grade

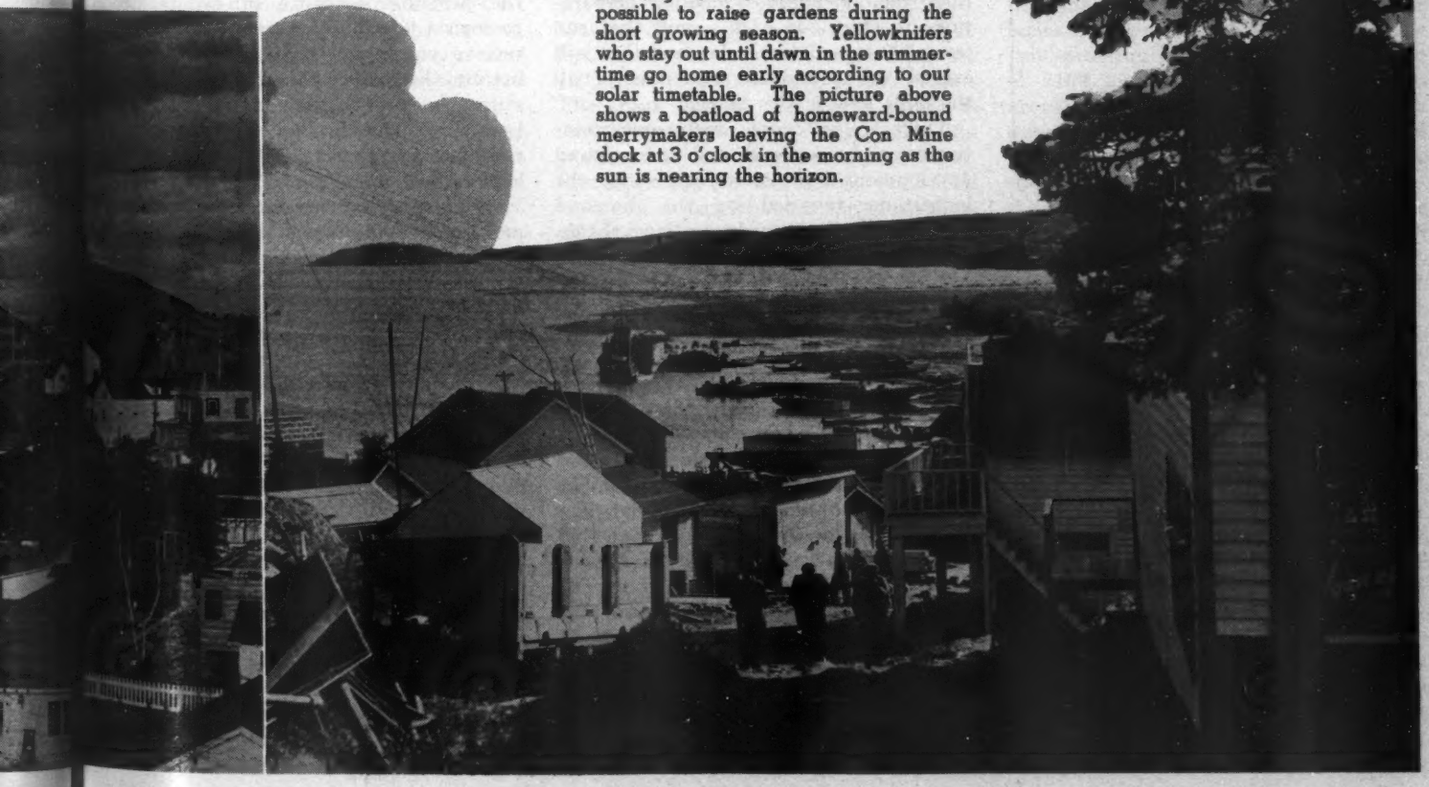


in outcrops along the west side of Yellowknife Bay near where the town was later established.

News of these strikes precipitated a mild rush of prospectors in 1935, and between 500 and 600 claims were staked that year. From the development work that ensued, six producers were opened. The Con Mine of Consolidated Mining & Smelting Company, Ltd., was the first to get into operation and poured its first gold brick in August, 1938. The Negus, adjoining the Con on the east and south, began producing in 1939. Others that joined the ranks soon afterward were the Thompson-Lundmark, at Thompson Lake, 35 miles northeast of Yellowknife; the Slave Lake (now International Tungsten Mines, Ltd.) on Outpost Island; the Ptarmigan, at Prosperous Lake; and the Ruth, in the Francois Lake area. With Canada in the war, labor became increasingly scarce as the men left to serve the colors, and one by one the properties were forced to close. The Negus was the last to shut down in October, 1944. In this brief period, during most of which the mines were handicapped by a labor shortage, they produced more than $14,000,000 worth of gold.

Although ore stopped coming from the ground, the search for other commercial deposits continued as the war went on. Government Regulation M.C.19 prohibited shaft sinking and underground development work, so numerous companies resorted to probing the ground with diamond drills in an effort to locate ore bodies and to obtain core samples that would give a general idea of what



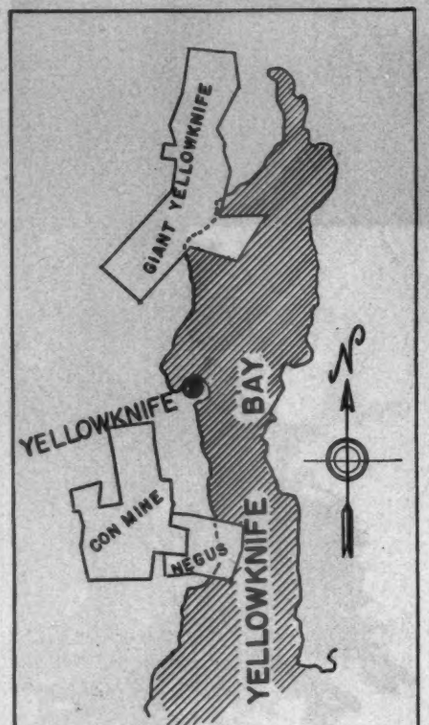


AROUND YELLOWKNIFE

The original town of Yellowknife (lower-left) was built on a rocky headland jutting into Yellowknife Bay. Atop the highest point was erected a water-storage tank to supply a distribution system in which the pipes are all above ground because of the expense of trenching in solid rock. Consequently, the system can be used only in the summertime. A roadway leading down to the waterfront is seen directly below. Yellowknife is now gradually moving to a new townsite 1½ miles inland. The ground there is sandy and will permit of economic excavation for water and sewer lines. Although Yellowknife is only 250 miles south of the Arctic Circle, the summer temperature ranges up to 85°F. and, with the long hours of sunshine, makes it possible to raise gardens during the short growing season. Yellowknifers who stay out until dawn in the summertime go home early according to our solar timetable. The picture above shows a boatload of homeward-bound merrymakers leaving the Con Mine dock at 3 o'clock in the morning as the sun is nearing the horizon.

MINE LOCATIONS

Map indicates relative positions of Giant, Con, and Negus claims on the west side of Yellowknife Bay. Diamond drilling on Giant ground has revealed large lenselike ore bodies within a shear zone that has a north-south trend. Geologists reasoned that its southern extension, offset by the West Bay Fault, might cut across the Con and Negus mines. When drill holes were put down on the Negus property to test the theory a mineralized belt was intersected. It is not yet definitely known what relation, if any, it bears to the Giant structure. Yellowknife is shown at its original site.



returns might be expected from actual mining operations. Surprisingly good results were realized by Giant Yellowknife Gold Mines Limited on a group of claims extending for more than 12,000 feet on the surface. Between January, 1944, and January, 1946, approximately 200 holes, having a combined length of 84,000 feet, were put down to a depth of 700 feet. Computations based on them indicate that, within the limits explored, Giant probably has more than 2,000,000 tons of ore of a grade high enough to yield a profit. Just how much more lies underneath the 700-foot depth remains to be disclosed by further probing.

Drilling at Giant has changed previous conceptions of Yellowknife's ore occurrence and aroused hopes that the district may become a large producer. Most of the output of the established mines has come from rich but narrow and erratic veins that can yield only relatively small tonnages daily. In contrast, the Giant ore bodies have been found to be large, some of them having widths of 200 feet. Consequently, the prospects are that a big daily output can be developed. Although the ore is not so rich as that of the properties previously worked, the possibilities of profit are interesting, inasmuch as operating costs per ton normally decrease as output rises. In view of these factors, Giant is making preparations to start out with a mill that can treat 500 tons of ore a day and that will exceed the combined capacities of all the mills now in the district.

There are, of course, many uncertainties yet to be resolved, and underground development work alone can verify the indications revealed by the diamond drills. Giant has already sunk two shafts, and from one of them, in the southern end of the property, it has driven approximately 2000 feet of crosscuts and drifts up to the middle of July. Thus far, this underground development work has fully corroborated the findings of the drill holes put down from the surface.

The disclosures at the Giant claims are important not only in themselves but also because they point to the possibility of the existence of similar large ore bodies elsewhere in the district. To understand why this is so it is necessary to have a brief look at the geology of the area. The picture cannot be a clear one, for the underground arrangement of the rocks is complex. Up to date, the evidence at hand is not sufficient to draw definite conclusions but, rather, only to conjecture as to what may be found. The geologists themselves admit that they are dealing with a jigsaw puzzle that has to be pieced together bit by bit. It may be years before they know whether the theories now held are correct; but, at least, each additional bit of information obtained as the program of probing continues seems to fit into the pattern they have visualized.

The predominating rocks are greenstone that was formed in Archean times, the oldest geologic age. In reconstructing the probable sequence of events, the geologists attribute their origin to extensive volcanic flows. After their formation, there was a period of intermittent vulcanism and sedimentation, followed by one of sedimentation alone. Into the resultant crust were intruded granitic lavas from below, and then there was folding that produced faults. Repeated movement along the fault planes broke up the rocks alongside the latter for considerable distances, causing what are known as shear zones. In them is found the mineralization that characterizes the Giant ore bodies.

Subsequently, there were more granitic intrusions and then crustal disturbances that crossfolded all the existing rocks. Still later came intrusions of diabase dikes and, finally, a period in which major faults cut across all the rocks and the mineralization they enclosed. The latter faults resulted in dislocations in the earth's crust that are among the largest known. The breaks run in a generally north and south direction, and most of the displacement was horizontal rather than vertical. Apparently, the rocks on the west side remained in place and those on the east side were pushed northward and downward. In some in-

UNDERGROUND DRILLING

The views on these two pages show air-operated rock drills in action at the Negus Mine. At the left, a miner is climbing into a stope with an SAR-120 stopehamer. Not in the picture is a helper at the end of the towrope attached to the machine. In the next illustration, Miner Archie Hanrahan is operating the drill. During the enforced wartime suspension of production, the Negus kept those of its force that were not called to the colors busy on development work. The main shaft was deepened 350 feet to the 1250-foot level. The two right-hand views show two miners drilling blast holes for excavating a sump at the bottom of the shaft. They are using a DA-35 drill equipped for sinking work.

stances the lateral movement was as much as 5 miles. Faulting extended over a belt approximately 10 miles wide, and the cumulative movement along the several planes aggregated 11 miles. In contrast with the earlier faulting, the movement took place along extremely narrow fractures and there was little mineralization and only slight alteration of the wall rocks.

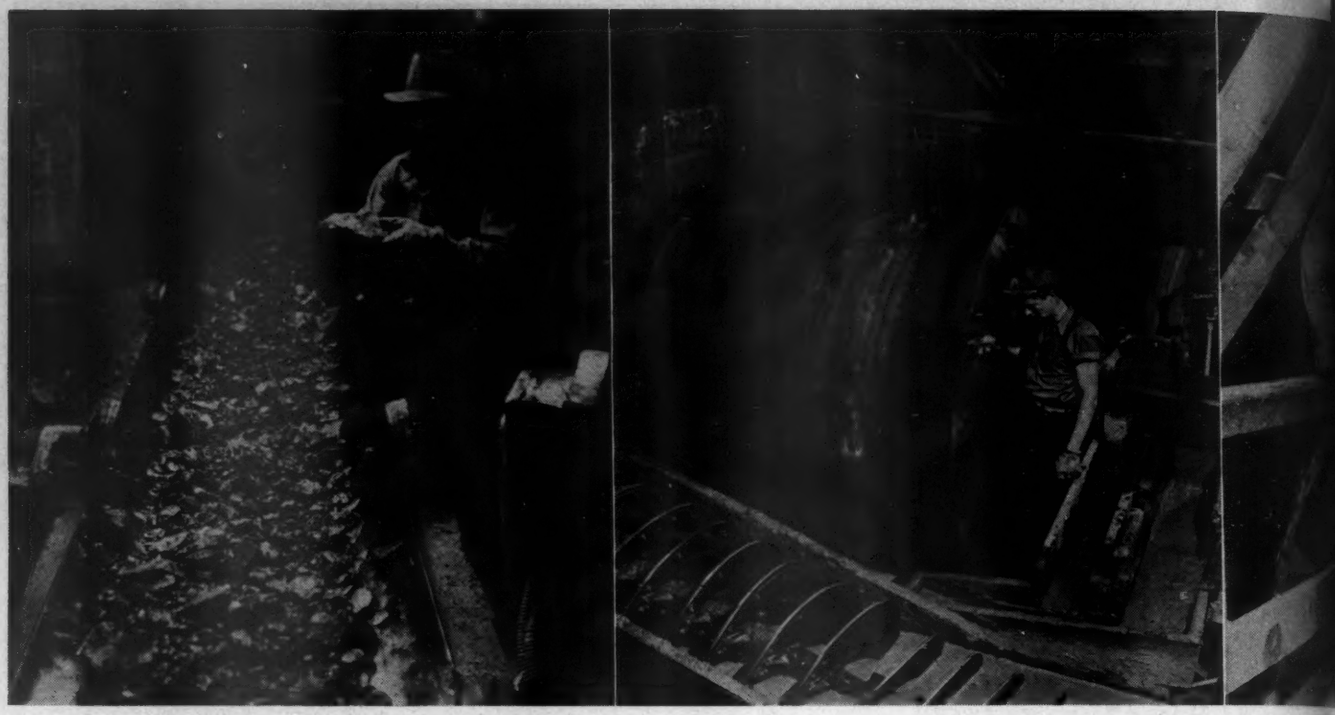
Most of the foregoing facts and theories have been developed since Giant started its diamond-drilling program. Before that time it was assumed that the narrow, comparatively short quartz veins discovered in the earlier mines constituted the only type of mineralization present. As succeeding diamond-drill holes shed more light on the complicated underground pattern, however, it was realized that the wide shear zones enclosed much larger and more important ore deposits. Geologists also began to speculate as to the possibility of finding extensions of Giant shear zones on adjoining properties.

As more information was accumulated, it became apparent that the West Bay Fault, one of the great crustal dislocations of comparatively recent geological times, cut across the principal shear zone in Giant ground. The evidence indicated that the rocks on the east side of it had been moved downward approximately 1000 feet in addition to being shifted northward several miles. If this were true, the geologists reasoned that an offset of the Giant shear zone might be found southward and westward. As the Con and Negus properties are about 3½ miles south and a little west of the Giant holdings, they considered it likely that such an offset, if it did exist, would extend into their ground. The calculations indicated that it would lie below the lowest workings in the two older mines. To test this theory it was decided, in August, 1945, to direct a diamond-drill hole 2500 feet downward on a 45° angle from the 1250-foot, or lowest level, of the Negus. The shear zone on the Giant claims is east of the West Bay Fault, while the workings in the Negus are west of it. Consequently, the Negus hole was drilled eastward to pass through the fault plane and into the area where the shear zone might be expected to be.

Confirming the hypothesis of the geologists, the hole intersected a mineralized shear zone at a depth of 2100 feet and 1800 feet east of the Negus shaft. The findings were not indentical with those made in Giant ground in that no wide, massive ore bodies were pierced. However, three narrow veins that yielded cores assaying up to $68 a ton in gold were penetrated. A second hole was then put down from the surface, and it also intersected veins of commercial grade. A third hole was completed in July with similar favorable results. In a further effort to prove the validity of the theory, more diamond-drill holes are being put down on the Con property.

Besides revealing additional deposits on the Negus property, the drilling program has brought out the important fact that ore exists at considerable depth. Hitherto, it was fairly generally believed that the narrow veins did not persist far beneath the surface. Now that a new vein structure has been found at a depth of 2100 feet, strong hopes have been aroused that the veins that have been mined may also have deeply embedded roots and will therefore support profitable operations for years to come. The immediate effect has been a decision by the Con management to sink its 1400-foot shaft another 450 feet at least, and possibly 900 feet. During the wartime shutdown, the Negus shaft was deepened from 900 to 1250 feet and two new levels were opened.

Both the Negus and the Con have, from the beginning, yielded ore of unusually high grade, which explains why they could show profits in an area where operating costs are high. From the time milling started in February, 1939, until the end of 1945, the Negus produced gold valued at $4,732,325 from 139,585 tons of ore. This was an average of $33.90 per ton treated. In all, six veins have been worked. Five of these are close to the Main No. 2 Shaft. The largest is the No. 15 Vein, which has accounted for 47 percent of the tonnage and 50 percent of the gold. It is seldom more than 4 feet wide and ranges from 200 to 300 feet long. It



MILLING SCENES

This group of pictures was taken in the Negus mill, which was designed to treat 50 tons of ore daily but has been handling between 60 and 70. As the crude ore is conveyed to the mill, some waste is eliminated by hand sorting (left). In the background of the next view is a ball mill for fine grinding the ore. In the foreground is a screw conveyor elevating pulped ore for regrinding. The third picture shows an oiler lubricating gear on a belt-conveyor drive.

yields ore containing up to 12 ounces of gold per ton. The Negus mill has a rated capacity of 50 tons a day but has been treating 60-70 tons. Between 1938 and the time of its closing in 1943, the Con Mine produced approximately $7,000,000 in gold from ore averaging $27.72 per ton. It has a mill of 350 tons daily capacity.

Of the other established mines, the most important one is the Thompson-Lundmark northeast of Yellowknife. It has been developed through two inclined shafts, 600 and 750 feet deep, and has a 125-ton mill. Up to the time of its closing in September, 1943, it had an output of $1,765,000 from ore that averaged $24 a ton. Preparations are now being made to reopen it; but, in view of the important diamond-drill results on other properties, several prospect holes will be put down before the water that has been allowed to flood the workings is pumped out.

Yellowknife is still a colorful pioneer mining community, but it is settling down to serious business. The year 1944 was one of wildcatting, of scrambling for claims and making deals. Money was plentiful, and Yellowknife was a magic word to people in both Canada and the United States who bought stock in various promotional schemes rather indiscriminately. Now a period of development has begun. New claims are being recorded at the rate of only 250 per month, as compared with nearly 800 a month last year. A sifting process is underway, and from it will emerge the properties that warrant thorough testing. Meanwhile, activities are fanning out into an area extending 200 or more miles from the town of Yellowknife. At Indin Lake, Sunset Lake, Gordon Lake, Campbell Lake, along the Snare River, and in many other out-of-the-way sections, showings of ore are being prospected to determine whether they have the makings of mines.

Enough has been learned already to assure Yellowknife its place on the map. A city of from 5000 to 10,000 population is foreseen in the not-too-distant future, and the more optimistic residents are talking about 50,000. Regardless of how far it goes, Yellowknife has come a long way. In the beginning, it consisted of one commercial establishment, Peter Racine's "stopping place" on Latham Island. Then two warehouses and a wharf were built on the mainland, opposite the island and a little to the south. Racine promptly moved over to the mainland and set up the Corona Hotel. When the slump developed, it was taken over in 1943 by the American Metals Company to serve as headquarters for its exploration force.

The first Yellowknife arose on a rocky headland that juts out into the bay. In 1938 the Northwest Territorial Council sent R. W. Clarke there to survey the area and to lay it out in lots. Those lots were not sold, but were allotted to applicants on 5-year leases that were cancelable upon six months' notice if the owner of the mineral rights needed them for surface operations. Sections of the townsite rested on claims of the Conwest Exploration Company, and diamond drills were set up almost in the backyards of some of the settlers. Most of the buildings were of logs or rough-hewn lumber, and that same architecture persists today. Many of the homes are tents with sides and floors of boards and with only oil- or wood-burning stoves to provide a measure of comfort in winter temperatures of 40 and 50° below zero Fahrenheit.

In 1940 a summer-community water-supply system was installed, with a reservoir tank atop the highest ridge and piping laid on the surface to feed fireplugs and numerous hose connections. It was prohibitively expensive to bury pipes below the frost line where every foot of trench had to be drilled and blasted. After the discoveries on the Giant holdings had given evidence that Yellowknife was probably going to grow considerably, the Dominion authorities sent in a town planner to pave the way for orderly development that would avoid some of the confusion normally attending the establishment of remote mining communities. It was decided to relocate Yellowknife on a sandy plain about 1½ miles from the old site and closer to the airport that is a vital feature of the transportation set-up. The new townsite will provide from 700 to 1000 lots for building purposes and will also permit laying water-supply and sewage piping systems underground at reasonable cost. A nearby lake will serve as a

UNDERGROUND WASTE DUMP
Negus miners are shown at the left tilting a 1-ton side-dump car to discharge rock into a waste pass. Some of it is later hoisted and used for roadbuilding and construction purposes.

water source. As in older communities closer to building supplies, there is a housing shortage, but construction is proceeding as fast as materials can be obtained.

The local government is administered by a council of five men, headed by a permanent government official who happens to be the liquor vendor. This group assesses a low municipal tax against lot leasers and also collects 25 cents on each case of beer sold. The latter source of income is not as stable as might be imagined, however, for beer is a heavy commodity and during the winter freeze-up the town often goes months without seeing any of it. In the early days, liquor was plentiful and residents could have two bottles a day each if they so desired. Now it is rationed on a basis of one quart a month, and nonusers sell their allotments for fancy prices.

During the past summer a drive has been underway to raise $250,000 for a community hospital with 40 beds and an adequate staff. The Canadian Red Cross will operate the institution and has also subscribed $75,000 towards its cost. So far, critical cases have been cared for at the 15-bed hospital maintained by the Consolidated Mining & Smelting Company at the Con Mine, but it was originally intended only for the company's personnel and is entirely too small to meet the needs of the town and outlying sections.

In line with the fluctuating mining activity, the population has had its ups and downs. At the height of the initial boom there were more than 2000 inhabitants, but the number was reduced to 1300 in 1941 and to 900 in the fall of 1944. By June, 1945, there were 2500 persons in or close to the community and an estimated 1000 in the bush. The postmaster's count last fall was 3200, and unofficial estimates now indicate 4500.

Transportation facilities to Yellowknife are adequate, but it is a costly journey for passengers or commodities. The summertime overland route is by railroad from Edmonton to Fort McMurray, thence by barge down the Athabaska River to Lake Athabaska, and from there by Slave River to Great Slave Lake. Between Fitzgerald and Fort Smith on the Slave River there is a 16-mile portage where everything has to be transferred from barges to trucks, hauled overland, and then loaded back into barges. Most of the latter are powered by diesel engines, and the entire trip normally takes eight days. The charge for freight is around $50 a ton. The water route is navigable only about three months a year, for ice ordinarily does not break up in Great Slave Lake until around June 20. When it does, there is excitement in Yellowknife because the church runs a sweepstake on the time the first boat from the south will pass the Negus dock. In winter, some tractor trains come in over the frozen ground from Grimshaw, Alta., from which point the government is now constructing an all-weather highway that makes partway use of a road built several years ago to the Fort Norman oil field. It will be 390 miles long and is scheduled to open in 1947.

Chief reliance in the winter season is now placed on air transportation. Formerly the planes were equipped with either pontoons or skis for landing, and there was a period during the spring thaw and another one during the fall freeze-up when both were useless. In 1944 the Canadian Pacific Airlines established an all-weather airport where craft accommodating up to fifteen passengers can land on wheels, and a 3½-mile road, constructed by the government, connects the airport and the old townsite. The air express rate from Edmonton to Yellowknife is 50 cents a pound for most commodities, with a special rate of 35 cents for perishables. From Yellowknife to the outlying sections, planes are the chief means of transport. About 80 parties of diamond drillers and prospectors are regularly serviced by the Canadian Pacific Airlines, and several companies have their own planes.

It can readily be appreciated that the launching of a mining operation in the Yellowknife area is an expensive undertaking. Diamond-drilling charges alone run around $4.50 to $5 a foot. The drills are powered with gasoline engines, and the fuel has to be flown to the sites. Living costs at Yellowknife are not as high as might be supposed, because Canada's price-control regulations are in effect there. In the summer, refrigerated barges bring in perishables, and the Con Mine has sizable storage facilities where they are kept in good condition for weeks or months. When supplies run short, they can always be flown in, but of course at greater cost. Crews in the hinterland must subsist at times on limited fare, for there is no open season on game in the entire Northwest Territories, embracing 1.3 million square miles of land. This law was enacted for the protection of 1000 Indians who occupy a reservation of some 70,000 square miles. In cases of dire necessity, however, prospectors are permitted to kill animals to eat.

Power has an important bearing upon the expense of mining operations, and the problem of providing it at reasonable rates is a real one in such a remote place as Yellowknife. There is no close source of coal, and shipping it in under existing transportation conditions is out of the question. Diesel and gasoline engines are used to a considerable extent, the fuel for them being brought up the McKenzie River from Fort Norman in the summertime and stored at Yellowknife, where the Imperial Oil Company now has tanks with a capacity of 360,000 gallons. Costs are high, however, compared with those in established mining sections. Hydroelectric development offers the best solution of the power question, but here again there are obstacles. On the only nearby site, on the Yellowknife River, the Consolidated interests built a 4700-hp. plant in 1937. This station supplies their mines and the town of Yellowknife and

CON MINE

This property of the Consolidated Mining & Smelting Company, Limited, was the first Yellowknife mine put in production and had an output of around $7,000,000 up to the time of its closing in 1943 because of a labor shortage. Its shaft is now being deepened preparatory to the resumption of mining.

leaves a small surplus that is sold to Negus and other consumers at $100 per horsepower per year.

When the magnitude of the Giant ore bodies began to unfold, it was immediately realized that additional waterpower resources would have to be developed, and the Surveys and Engineering Branch of the Department of Mines and Resources at Ottawa conducted surveys of the area to determine its possibilities. Those investigations indicated that, in the whole general region under consideration, 690,000 hp. might be made available for six months of the year and 230,000 hp. for the entire year. After various sites had been examined, it was decided that the most suitable one for current needs is on the Snare River, northwest of Yellowknife Bay. On July 3 of this year, Giant officials signed a contract with the government to take power from that source and preparations were made to develop it.

The area selected can eventually provide 25,000 to 30,000 hp., but work on the project will be carried out in three stages to be completed as future demands dictate. The first stage involves damming the Snare River below a point where it issues from Big Spruce Lake, thus utilizing the latter as the principal part of a storage reservoir. Water will be available to generate 8000 hp. The second stage envisages diverting water from Big Spruce Lake through a chain of small lakes and valleys to other power sites. One of these will develop from 15,000 to 20,000 hp. and another 10,000 hp. The government will defray the cost of construction. It will sell current at cost to Giant, which has agreed to build a 94-mile transmission line at an estimated expenditure of $1,100,000 with the understanding that it will subsequently be purchased by the government. The contract provides that other users may obtain power from the system, which is expected to be in operation late in 1948.

Meanwhile, Giant, which is controlled by Frobisher Exploration, B.E.A.R., and the Consolidated Mining & Smelting Company, is going ahead with its plans to get into production. As the first step in its operations it will mine the ore bodies down to the 300-foot depth. It is calculated that there are within that horizon 1,142,800 tons grading around $12.25 a ton in gold—enough to run a 500-ton mill for 6½ years. The ore exists in leases which, in the aggregate, comprise one of the largest gold-bearing structures ever opened up in Canada. The mill will be laid out so that its initial capacity can later be doubled or even raised to 2000 tons a day. Power for the mining operations is now being generated by diesel-engine units. Two more 400-hp. engines were taken in this year. The two shafts started operating with a 650-cfm. compressor at No. 1 and a 1000-cfm. machine at No. 2. Machines to provide 1500 more cfm. were received during the summer.

Mining and milling costs, based on a daily production of 500 tons and power generated by diesel engines, are estimated at around $9 a ton, but it is believed that they can be reduced by $2 or $3 a ton when output is increased to 1000 tons a day and hydroelectric power becomes available. By selecting the ore mined during the period of low production, it is thought that mill feed averaging around $15 a ton can be obtained. The development work that was done up to July 15 yielded 4132 tons of ore running $15.40 a ton and 1383 tons averaging $4.20 a ton.

NEGUS SHAFT HOUSE

This main or No. 2 Shaft is 1250 feet deep. The mine resumed operations in July, 1945, after a shutdown of nine months enforced by a lack of miners. Since it was opened in 1939, the Negus has produced ore averaging almost an ounce of gold to the ton, making it one of the highest-grade gold mines in the world.

French Slate Industry

S. Gradel

GENERAL VIEWS

At the top is an over-all view of the "butte" or slate-working area. In the foreground are rows of small workshops where blocks of slate are reduced to shingles by hand. Finished shingles may be seen arranged in lines on the opposite sides of the walls flanking the shops. In the background are modern buildings housing machinery for sawing the large blocks into suitable sizes for splitting. The other picture shows the headframe over the shaft extending to the underground slate deposits.

SLATE deposits of workable size and quality exist in various districts of France, including the Ardennes, Savoy, the Pyrenees, the Centre, in Brittany, and the Angers Basin. The greatest development of commercial workings is in the Angers Basin. It is claimed that French production of slate as a roofing material dates back to the sixth century, to the time of St. Lezin, who still remains the patron saint of slaters. There is no documentary evidence to support this claim, but there are various authenticated examples of the stone's early use. Slate has been found in old Gallo-Roman masonry work; a sculptured-slate tombstone reportedly taken from the grave of Abbot Atto, who died in 835, is preserved in the St. Jean Museum in Angers; another one, dating from the Merovingian line of Frankish rulers (486-752) that supposedly marked the burial place of Sandrebert, reposes in the Daubree Museum in Nantes. These isolated cases do not, however, constitute proof that quarries were operated in those times.

Viollet le Duc states in his dictionary that many roofs were covered with slate in the eleventh century and still more in the twelfth, but the only indisputable example he gives of this use of the material is the St. Cyr Cathedral at Nevers. In a brief history prepared by M. Soulez-Lariviere, president and general manager of the principal Angers slate-producing company, there is an account of the discovery of Maine medals of the twelfth century in excavations that were made in 1832 at Trelaze near Angers. Finally, a work published by Camille Rivain, registrar in the National Registry Office, shows that in 1345 a quarry at Juigne-sur-Loire supplied the slate required for the reconstruction of the Chateau de Beaufort.

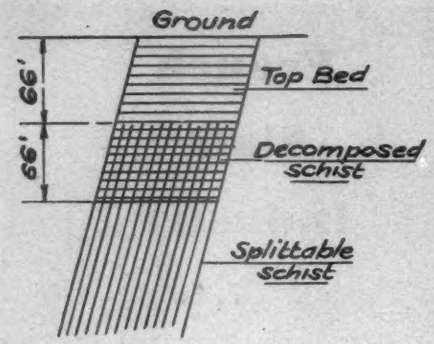
The Angers-Trelaze district is in northwestern France and about 100 miles from the west coast. The slate, or slate schist, found there is of light weight and can be split so readily that sheets not exceeding 3 millimeters (0.118 inch) in thickness can be obtained. Almost 99 percent of the stone is made up of quartz and silicates of alumina. Consequently, it is virtually impervious to moisture; in fact, a vat made up of slabs only 1 millimeter (0.03937 inch) thick will retain water without leaking. This is one of the properties that make slate a desirable and durable roofing material.

The slate veins dip so steeply that they are almost vertical, and the laminations which render the stone so cleavable are parallel with the dip. Veins of slate that splits easily enough to make its exploitation desirable usually do not reach the surface. There is generally a top bed of altered schist, called *cosse*, that averages around 65 feet in thickness. Underneath this is a stratum of unsplittable schist that also is about 65 feet thick. Then comes the slate of workable quality.

The method of extraction currently practiced is the result of evolution that is now in its third stage. Under the French law the slate, regardless of its depth, is the property of the owner of the surface land above it. In the beginning, a deposit could not be opened through workings extending from the surface land of another owner. Inasmuch as no mechanical equipment was then available for sinking vertical openings or for hoisting, access to the deposits had to be gained from hillsides.

Quarries were opened on such slopes and worked across the width of the vein. As operations progressed, the overburden grew increasingly higher and had to be coped with because the work was carried on entirely in the open. No effort was made to extract the slate at levels below the quarry floor. The excavation was usually limited to a surface area of 600 to 700 square yards and the stone was removed in tiers or benches about 10 feet high. The work was difficult because of the crude equipment used and was made precarious by the danger of landslides that were apt to terminate the activities at any time.

That method of attack prevailed until

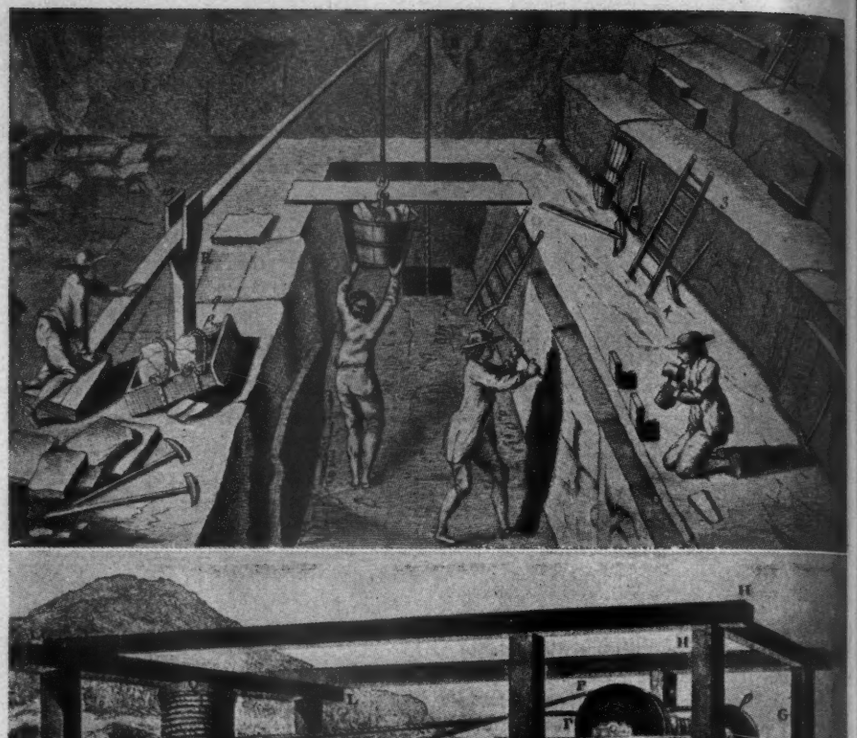


GEOLOGICAL SECTION

The good-quality slate or schist lies at a depth of approximately 130 feet, which explains why underground mining methods are required to extract it.

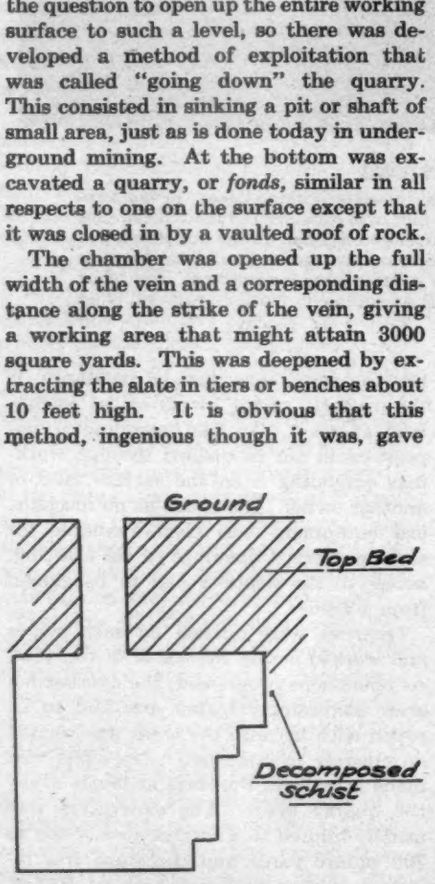
around the middle of the nineteenth century. By that time the more accessible outcrops had been quarried and, simultaneously, builders began to be more exacting as to the quality of the slate they would accept. Consequently, it became necessary to get at the veins lower down, and this involved excavating through the overlying *cosse* and the mediocre schist to a depth of around 130 feet. It was out of the question to open up the entire working surface to such a level, so there was developed a method of exploitation that was called "going down" the quarry. This consisted in sinking a pit or shaft of small area, just as is done today in underground mining. At the bottom was excavated a quarry, or *fonds*, similar in all respects to one on the surface except that it was closed in by a vaulted roof of rock.

The chamber was opened up the full width of the vein and a corresponding distance along the strike of the vein, giving a working area that might attain 3000 square yards. This was deepened by extracting the slate in tiers or benches about 10 feet high. It is obvious that this method, ingenious though it was, gave rise to conditions of insecurity. Any geologic accident was sure to be attended by dire consequences, and there was always the danger of major displacements of the overlying rock despite the support provided by offsets left as deepening progressed. Notwithstanding the precarious aspects of the work, some *fonds* were sunk as much as 325 feet, creating vast openings which produced up to 325,000 cubic yards, or around 740,000 tons of slate.



MEDIEVAL METHODS

In the thirteenth century, slate was extracted from quarries opened on the sides of valleys where it outcropped, being removed in benches as shown at the top. Vertical quarrying became possible when horse whims (lower view) were developed for hoisting.



THE "FONDS"

Formerly a shaft was sunk to the top of slate of desirable quality. Then the opening was enlarged into a chamber and the underlying stone was removed by benching. This was called going down the quarry, or "fonds."

Because of the hazards concussion would involve, excavating had to be carried on without the use of explosives, and this obviously made the work slower and more difficult. In addition, to reduce to a minimum the amount of waste material hoisted to the surface, the crews were obliged to exercise great care—to make sure that most of the stone extracted would be usable. Because of these factors, encountering a fault or a zone of slate of mediocre quality was likely to enforce the abandonment of a *fonds*, with a loss of all or most of the money that had been spent in developing it. This method of working was made possible in the first place only because some mechanical equipment had become available by the time it was instituted. In the beginning, hoisting had to be done by man power alone. Then came horse-powered whims, and these were succeeded by steam-driven windlasses that enabled the slate producers to go fairly deep for their stone, as just described.

The third stage in the evolution is the scheme that is being followed at present. This so-called "ascending" method has been used satisfactorily since 1880 and is essentially what mining men call the pillar-and-chamber system. As in the

case of the *fonds*, a shaft or pit is sunk, but it is carried much deeper—ordinarily to a depth of around 1300 feet. Also, it goes down alongside the vein instead of in it. From the bottom of the pit and parallel to the vein is driven a horizontal gallery, called a collector, from which crosscuts are advanced to the vein at suitable intervals. The slate is brought out through these and thence through the collector to the shaft bottom for hoisting to the surface.

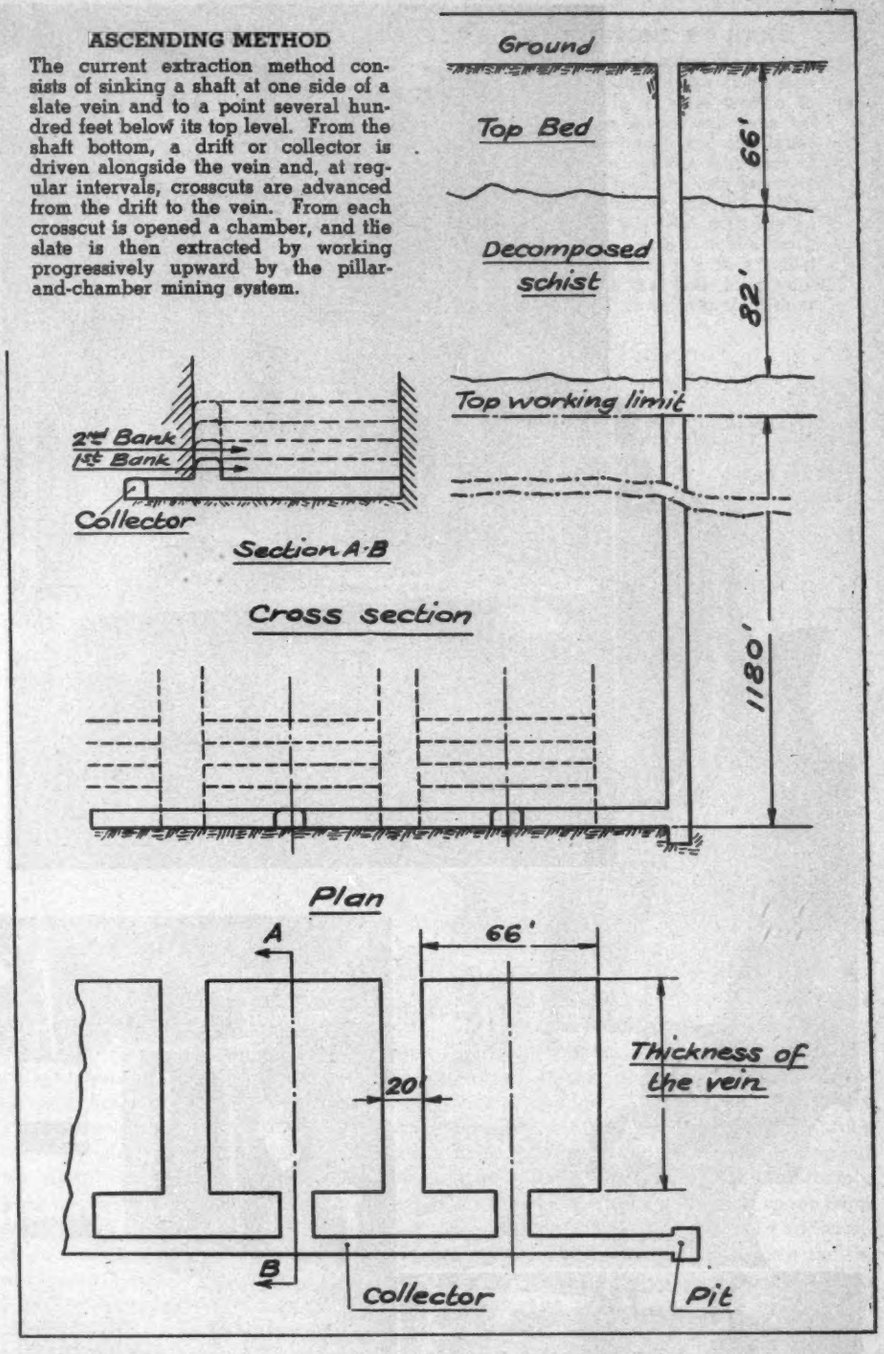
When a crosscut reaches the slate vein it is widened to 20-25 meters (65-82 feet) and is then carried forward to the opposite vein wall, attaining a length of from 20 to 30 and even 50 meters (65 to 164 feet) and a height of about 6½ feet. After this work is done, it is said that so many square meters of vaulting have been opened. As an accompanying drawing shows, a rib or pillar of slate 20 feet wide is left between adjacent chambers to support the overlying material. This insures that a landslide in one will not affect the others, which can go on producing.

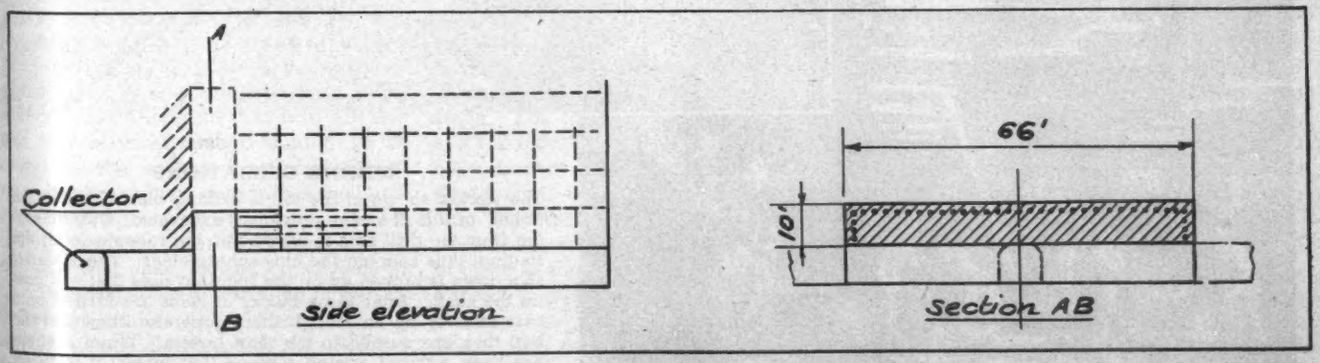
With the initial opening of a chamber completed, exploitation of the deposit can proceed. This is done by removing the overhead slate in tiers, working progressively upward until the unsplittable schist is reached. From six to eight chambers are ordinarily opened up from the collector, and all are served by the one pit or shaft. The total vaulted area will range from around 7200 to 14,350 square yards. Assuming that the extraction of slate is carried upward to within 100 meters (328 feet) of the surface, the gross volume of material removed will range from around 2,000,000 to 4,700,000 cubic yards. It is obvious, then, that the operations will extend over many years, and the equipment must therefore be of a very substantial and durable nature.

After a chamber has been opened to a height of 6½ feet throughout its entire area, the system of extraction is started that will thenceforth be followed. The first step is to excavate an overhead channel, beginning where the crosscut meets the slate vein and continuing across the

ASCENDING METHOD

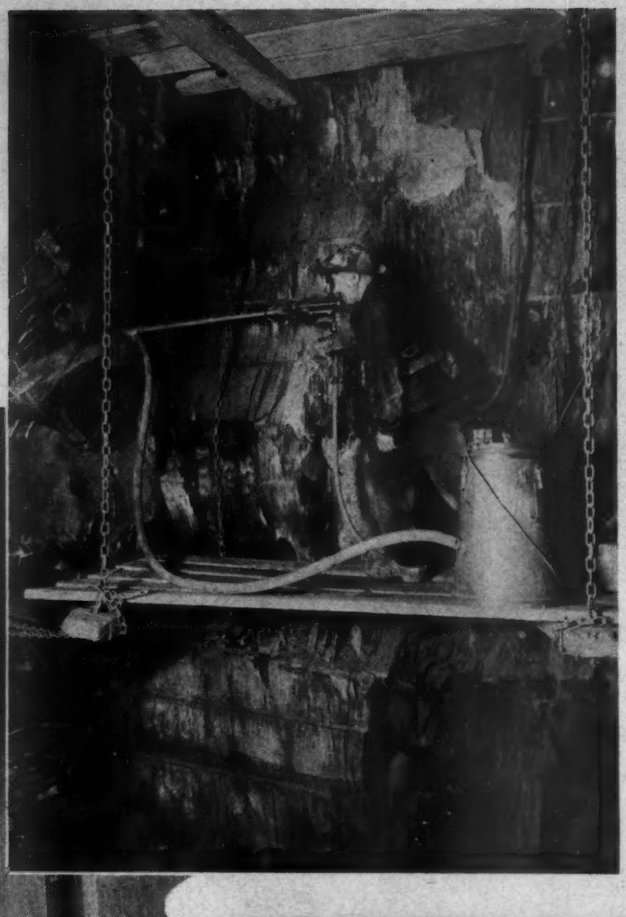
The current extraction method consists of sinking a shaft at one side of a slate vein and to a point several hundred feet below its top level. From the shaft bottom, a drift or collector is driven alongside the vein and, at regular intervals, crosscuts are advanced from the drift to the vein. From each crosscut is opened a chamber, and the slate is then extracted by working progressively upward by the pillar-and-chamber mining system.

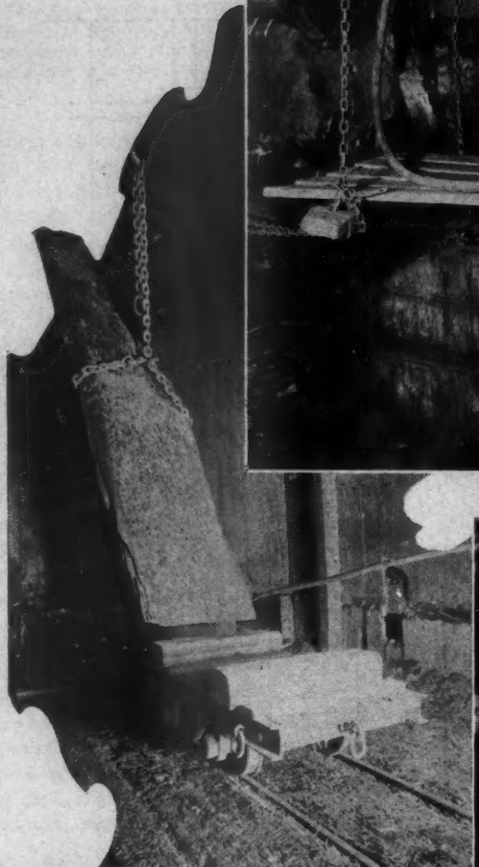


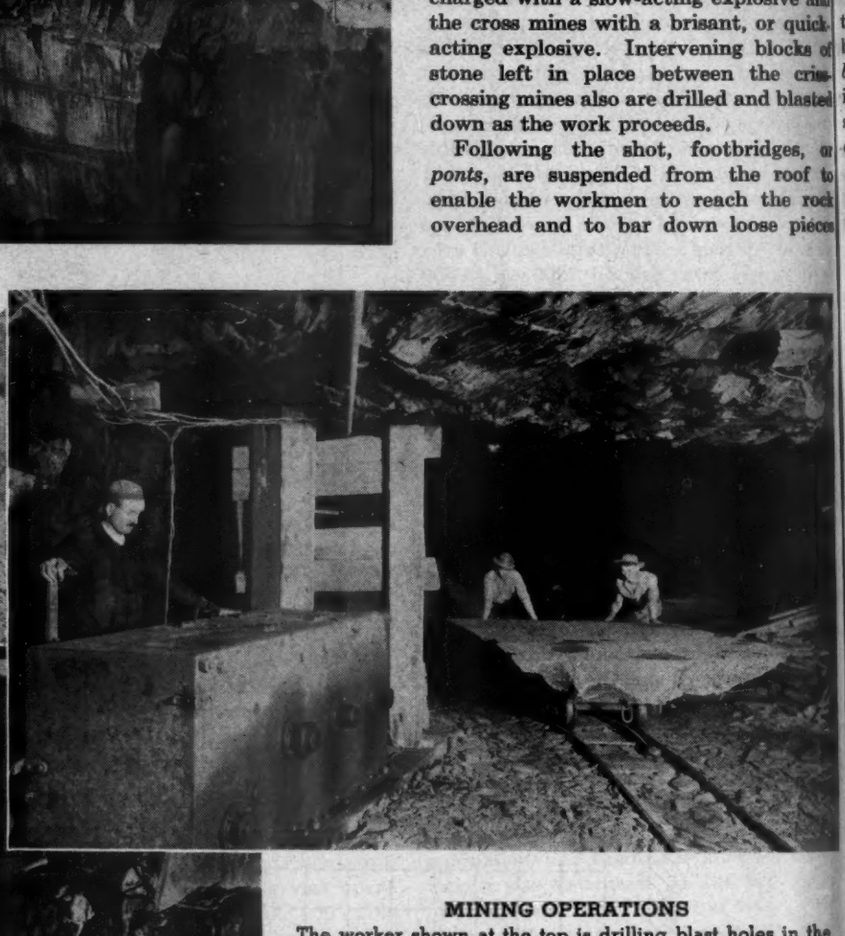


DETAILS OF CHAMBERING

The stone is excavated by driving a series of horizontal mines or drifts at right angles to one another, giving rise to a checkerboard pattern that removes the slate in rectangular blocks. After three lifts have been broken down, a new collector is driven at a higher elevation, and the procedure is repeated.







vein. This slot determines the thickness of the bank or tier of slate that is to be brought down. Depending upon local conditions, its height may be 13, 16, or even as much as 26 feet. It is just wide enough—around 5 feet—to provide room for attacking the slate on each side of it. The work of bringing down the first bank is begun in this central channel by driving horizontal "mines" or drifts into the vertical face of the exposed stone. These mines are 1 meter (39 inches) apart, and an advance of 1.2 meters (3.9 feet) is made at a time. Similar mines are driven into the sides or *chefs* of the first mines after they have been opened up. These secondary mines, which run parallel to the central channel, are spaced 0.8 meter (2.6 feet) apart. This procedure results in a checkerboard pattern that brings down the slate in rectangular blocks. After a series of these "rounds" has been drilled they are loaded and fired simultaneously. The primary mines are charged with a slow-acting explosive and the cross mines with a brisant, or quick-acting explosive. Intervening blocks of stone left in place between the criss-crossing mines also are drilled and blasted down as the work proceeds.

Following the shot, footbridges, or *ponts*, are suspended from the roof to enable the workmen to reach the rock overhead and to bar down loose pieces

MINING OPERATIONS

The worker shown at the top is drilling blast holes in the "chef" or side of a mine previously excavated. Dust emerging from the drill hole is drawn into the receptacle on the staging, thus keeping the atmosphere clear. The material shot down is broken up on the spot into sizes that will pass up the shaft. After those blocks or slabs are loaded onto cars (above) by an electric hoist (operator shown at the left) they are pushed to the shaft bottom. When a chain has been secured around a piece (left-center) it is ready to be hoisted to the surface. Staging or bridges are suspended from the roof after shooting so that loose material can be barred down and the workings rendered safe (left).

WORKING STONE BY HAND

The workman shown below has sawed a notch in the edge of the stone slab and is driving in a steel wedge to break it. Large pieces are thus reduced to "repartons," and the latter are split into sections the thickness of roofing slates. Splitting was formerly done as illustrated at the left. The worker wrapped his legs with burlap and used them as a vise to hold a block of stone while he split it with a mallet and chisel. Note that both men were wearing wooden shoes to protect their feet from injury.

that would otherwise endanger the men below. This operation is called *decalabrage*. Until it is completed and the workings are deemed safe or, as the French say, perfectly *decalabree*, other members of the crew are not permitted to approach the stone that was blasted down. This material is "worked" on the spot. Big blocks are reduced to pieces that will clear the shaft and that can be hoisted by the available machinery, the aim always being to obtain the largest possible number of blocks of maximum size. The waste is left where it is, thus building up the floor so that it can be kept close to the roof as overhead extraction progresses.

Three successive banks are brought down in the manner described, and then the collector is abandoned and a new one is driven at the higher level. Another set of crosscuts is advanced to the vein from the new collector, after which the cycle of operations is repeated. If the three banks broken down are each 6 meters (19.68 feet) high there will be a collector and system of crosscuts every 18 meters; if the banks are 3 meters high, the vertical interval between collector and crosscuts will be 9 meters. In the latter case, and with a chamber having an area of 1000 square meters (1196 square yards), 9000 cubic meters (9771 cubic yards) of stone, in the solid, will be brought down. The proportion of this total that is of suitable size and of good enough quality to be raised to the surface for finishing into marketable products determines the monetary return.

It is apparent from the foregoing that the operator must fix the dimensions of the chambers so as to insure an output of sufficient quantity to yield a profit. Inasmuch as one dimension of the chamber is limited by the width of the vein, the size of the opening is determined by the length to which it is extended along the vein. No general yardstick can be applied because the character of the slate also influences the size of the chamber. Variation in *doux* (splittability and freedom from faults) necessarily has to be considered, as well as the tendency of the stone to break out or otherwise to undergo geologic accident. Accordingly, the technical knowledge of the engineer in charge, the skill with which he plans the work both as regards extraction and subsequent manufacturing operations, is a big factor in conducting the enterprise on a favorable cost basis. Chambers with their longer dimension reaching 40 or even 50 meters (131-164 feet) have been worked successfully, but most of those now being exploited are in the range of 20 to 30 meters.

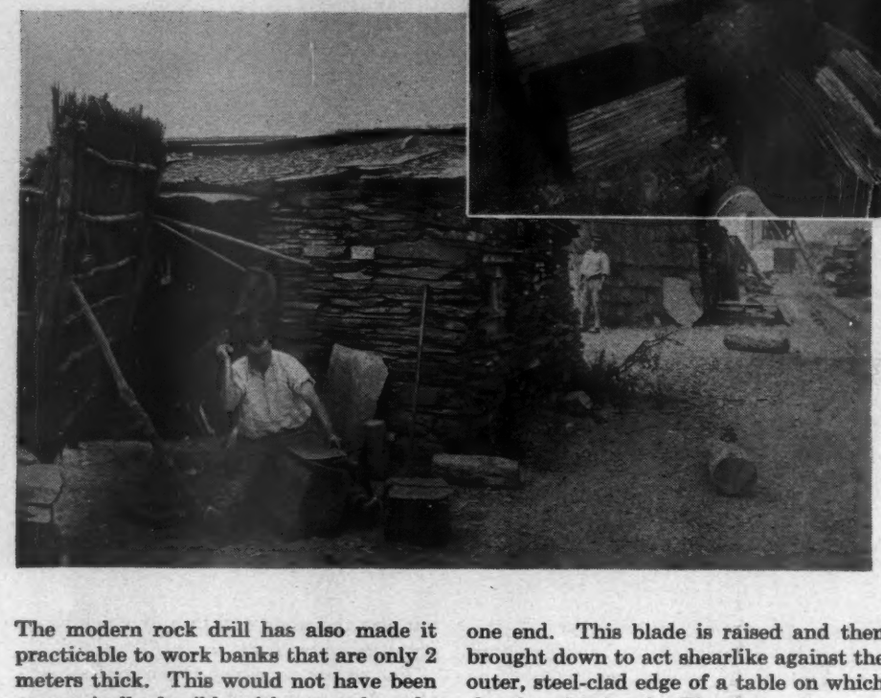
The thickness of the banks to be broken down depends upon the nature of the stone. The softer it is, the more fragile, and the more likely it is to fracture badly upon impact with the floor. For this reason some banks now being worked are only 2 meters (6.5 feet) high, and this permits keeping the floor close to the rock in place so that the latter has to fall only 1 meter or less, instead of 5, 8, or even 11 meters as in the case of thicker banks. Shock and, consequently, rupturing will obviously be less. Under these conditions there are other benefits. When the floor is close to the roof it is unnecessary to erect bridges to give access for trimming after blasting. This saves not only labor but also the wood and iron of which those structures are made.

The extent to which the mines are advanced at each working likewise is subject to change. If the grain of the rock becomes unfavorable at a certain distance from the face, the blast holes are stopped at that point. Instead of being uniformly 1.2 meters in length, they may range from 0.95 meter up to 1.90 meters. In addition, the spacing between mines may be reduced better to meet conditions. As a result, the intervening slab of stone is sometimes so narrow that a small charge of powder is sufficient to detach it.

It has already been mentioned that the development of power machinery made the third mining method possible, and there has been a growing tendency to adopt more and more mechanical aids. Today, all the chambers are well lighted with electricity, the large blocks are handled underground by power-driven hoists, and transportation to the pit bottom has been speeded by the use of rail cars designed for the purpose. Compressed air serves to advantage in numerous ways, and all drilling is done with mechanical rock drills. When hand drilling was practiced, two men could drive mines at the rate of 3 meters (9.8 feet) per shift, whereas one drill operator can now put in holes for 20 to 25 meters (65-82 feet) of advance in the same period.

EVOLUTION OF METHODS

Slabs of stone of shingle thickness were formerly trimmed to finished size by wielding a knife, as pictured below. Then came the cutting machine illustrated at the right. Originally designed to be worked by hand, it is shown here being run by a foot pedal, thus giving the operator the use of both hands for holding the slate.



The modern rock drill has also made it practicable to work banks that are only 2 meters thick. This would not have been economically feasible with manual methods because of the greatly increased number of drill holes required. The application of compressed air on the property where the accompanying pictures were taken are so extensive that three 200-hp. compressors are needed to furnish it.

Every block of slate that is suitable for the making of usable products is hoisted to the surface and then transported to workshops for processing. The manufacturing procedure has undergone evolutions just as has the extraction of the stone. In the beginning, the tools utilized were so crude that only thick slate could be turned out. This was "dressed" to a geometric pattern by allowing each edge to overlap a bar of iron or block of wood and then striking the projecting material to trim the stone evenly. The advent of steel chisels with thin and flexible blades permitted finer splitting until, finally, the prevailing thickness of 3 millimeters (0.118 inch) was arrived at.

Then came the dressing machine, which is now used in all slate-producing centers. It works on much the same principle as the machine that is employed for trimming photographic prints and that has a movable knife held in fixed position at one end. This blade is raised and then brought down to act shearlike against the outer, steel-clad edge of a table on which the slate is placed. The first units were operated by hand, but today they are controlled by a foot pedal, thus permitting the worker to use both hands to hold the slate. A scale marked on the table enables him to trim each thin slab to the exact dimensions of the various standard shingles.

The manufacturing process involves three stages. Blocks coming from underground are first cut into thick plates, called *repartons*. These are next split into slabs having the thickness of finished shingles. Finally, the slabs are trimmed to rectangular shape with even edges. These operations were formerly carried on in small shops having sides and roofs of straw to shelter their occupants from the elements. From two to five splitters worked in each one, which provided sufficient room to accommodate them and to permit separate stacking of the roofing slates they were turning out. In making the initial division, a *querneur* cut a V-shaped notch in the edge of a block. Into this notch he drove a flat steel wedge with a hammer having a flexible handle. He struck light blows until the wedge was well seated in the stone, which was made known by the metallic sound it gave off when hit. Then one heavy blow caused the block to fracture. Cutting, of course, had to be planned carefully so that the resultant plates would produce the maximum number of shingles, preferably of the larger sizes.

The *repartons* thus obtained from the original blocks were placed in a ditch containing water, because moistened edges facilitate splitting, the succeeding operation. The splitter used the lower parts of his legs as a vise for holding the slab, edge upward, and to protect them he wrapped them from knees to ankles with burlap or some other rough cloth. With a hammer and chisel he first split the piece at the center, then repeated this performance with the two halves, and so on until he had reduced the whole slab to sheets the thickness of shingles. These, termed *fendis*, were then trimmed and stacked according to size.

Under the modern system of manufacture, the thatched shelters have given way to spacious buildings equipped with machinery. They are located on a section of the grounds known as the *butte*. There the large blocks coming from underground are mostly sawed mechanically into *repartons*. The saw, of course, cuts the along the precise line desired, which even the best of the hand *querneurs* cannot do. Some blocks, however, are not suitable for handling by machine, and these are still dealt with by hand. Splitting is now done with the piece of stone held in a wooden vise that is opened and closed by a foot pedal. It is no longer necessary to stoop over to perform the operation, and women are able, after a period of training, to do the job as well as men.

At Angers, as in all slate workings, an enormous amount of waste is inevitable, but efforts to reduce it are continually being made. To this end, records are kept in each shop of the weights of the rough stones and also of the finished slates made from them. Through these figures it is possible to determine the best

INTERIOR OF MODERN SHOPS

The picturesque but relatively inefficient manual methods of working slate have been largely supplanted in recent years by mechanized equipment in shops of substantial construction (left). Some blocks of stone are not suitable, however, for machine work, and they are still turned over to hand "querneurs" (below).

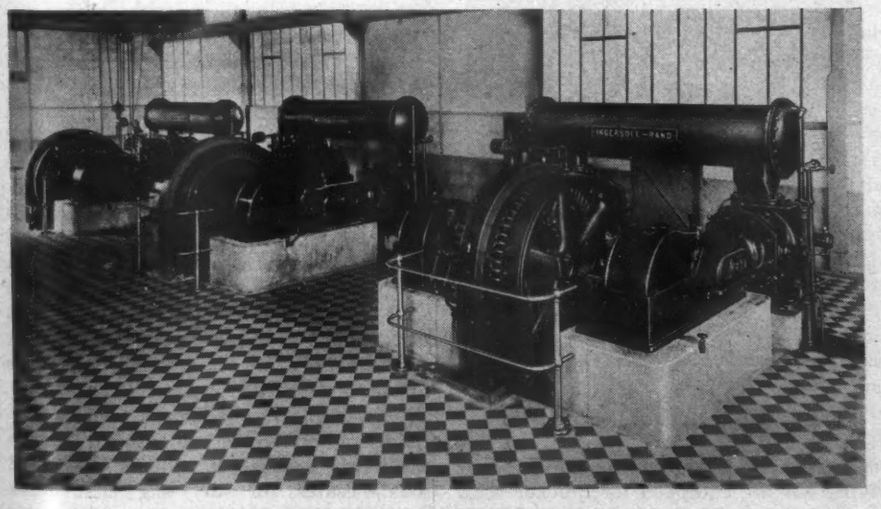
workmen, to whom is entrusted the job of dividing the blocks into *repartons*, for it is this operation that primarily governs the slates, in weight, that can be made from a block. Their skill likewise determines the quantity of large-size slates that a block will produce, and it is desirable to obtain as many large ones as possible.

Slates are cut in a wide range of dimensions for both the French and the English trade. For the former, they vary from 216 by 122 mm. (8.5 by 4.8 inches), with a thickness of 2.7 to 4 mm. (0.1 to 0.15 inch), to a maximum of 324 by 222 mm. (12.75 by 8.75 inches) with a thickness of 2.7 to 3.5 mm. (0.1 to 0.135 inch). The English sizes range from 10x8 inches, with a thickness of 0.15 to 0.195 inch, to 25x14 inches with a thickness of 0.18 to 0.235 inch. There is also a series of square designs from 10x10 inches to 14x14 inches. In addition to slates for roofing purposes, the stone is also fashioned into structural slabs suitable for tombstones, laboratory tables, sinks, acid vats, urinals, etc.

Complete records of production prior to the nineteenth century do not exist, but it is known that then, as now, the fortunes of the industry varied with the fluctuation in the volume of building construction. Likewise, it has always been true that the sales of roofing slate, which is the principal product, are seasonal, for roof laying virtually stops during periods of cold and rainy weather. In the face of these conditions it is apparent that considerable capital is required to enable operations to survive, and it has been available only within the past century.

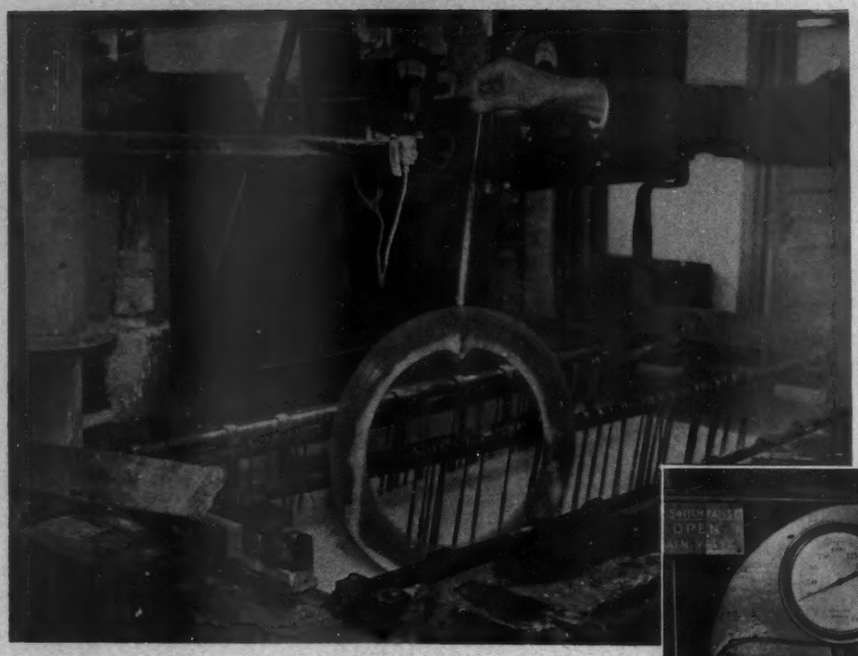
Prior to World War I, France produced annually around 300,000 metric tons of slate, of which 180,000 came from the Angers Basin. After the requirements of the postwar era had been satisfied, output dropped in 1938 to approximately 150,000 tons, of which the Angers Basin supplied two-thirds. Present production is at about the 1938 level, but a vast expansion is expected in view of the reconstruction that lies ahead. Preparations are being made to meet the demands insofar as possible, but there is a critical shortage of trained workmen.

Prior to 1914, the slate quarries employed 10,000 persons, but so few of them have returned to work since the war that there are scarcely 4000 on the payrolls today. Thanks to technical progress, they are able to compensate in fair measure both for the reduction in their numbers and in the length of the working day. Roughly, three persons are at present needed above ground for each one underground, and skilled workmen are required for three out of every four jobs.



AIR COMPRESSORS

All drilling is done with mechanical rock drills; and, besides operating them, compressed air is used for numerous other purposes. It is furnished by three 200-hp. compressors that have a combined output of approximately 4000 cfm.



PRODUCTION STEPS

At the left is the cleaning tank where the steel backing plates are prepared for electroplating in an alkali bath maintained at a temperature of 200°F. by a gas-air immersion heater. One of the presses which molds the powdered metal into rings is shown below. At the right in this picture is the oil accumulator which is loaded with compressed air to increase the stored energy and, thereby, the upstroke speed of the press cylinder. A special type of electric furnace (bottom) has been built to bond the powdered metal rings to the steel backing plates by both heat and pressure. The latter is applied by admitting compressed air into the diaphragm to which the operator is pointing. There are twenty of these furnaces in the Wellman plant.

Air Power in Production of Bimetal Brake Linings

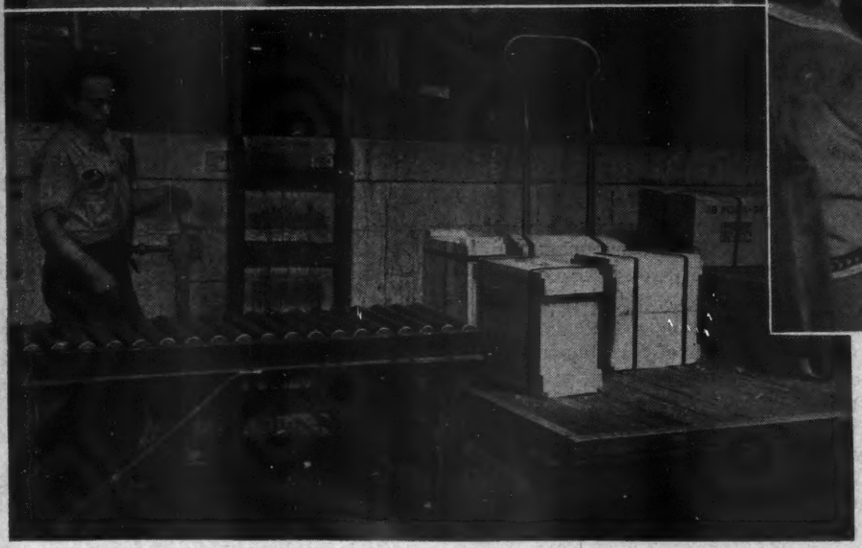
HOW things are done is always an intriguing subject, but all the more so if the field is a comparatively new one. Powdered metallurgy belongs in this category, and its applications are steadily becoming more numerous. For instance, in the making of clutch facings and brake linings for farm machinery, trucks, airplanes, machine tools, and other heavy-duty equipment, The S. K. Wellman Company is bonding powdered metal to backing plates by methods largely developed by it and which call for the use of compressed air all along the line from the raw to the finished products and, subsequently, in testing them.

The first step in the manufacture of this tough friction material is the preparation of the steel backing plates for electroplating. First they are washed and then submerged in an alkali bath that is heated and maintained at a temperature of 200°F. by a thermostatically controlled immersion burner. An air-gas mixture is used as fuel, the low-pressure air, supplied by a blower, serving to stimulate combustion and to give the necessary jetlike flame. A unit of the same type heats the washing solution.

In the meanwhile the powdered metal is made ready for sintering. Varying proportions of different kinds are thoroughly mixed to produce a uniform blend, of which predetermined amounts are placed in molds for compression in hydraulic presses. These machines, of which there are ten in service, are of the conventional type, but are equipped for quicker than normal action. Each is provided with an oil accumulator, a cylindrical tank in which energy is stored for the intermittent operation of hydraulic machinery. By loading the accumulator with compressed air the energy is increased and the press cylinder is brought into molding position in a few seconds, as against minutes when pressure is applied by a hydraulic pump.

The powdered metal is now in the shape of a ring, that, together with others of its kind, is ready to be welded to the backing plate. This is done by the application of both heat and pressure. As many as 75 rings, the number depending upon the size of the finished product, are bonded to the plate to form a single ring capable of withstanding friction and hard usage. A special type of electric furnace has been designed for this work by The S. K. Wellman Company. Mounted on top of it is a diaphragm into which compressed air is introduced and which serves to maintain a constant pressure of about 100 pounds per square inch on the multiple rings while they are being heated in the furnace. Compressed air was chosen for this purpose in preference to other pressure mediums because it adjusts itself and compensates for any sag that takes place during the 5- to 7-hour heating period.

Compressed air is supplied for all these and other services by five single-stage



OTHER USES OF COMPRESSED AIR

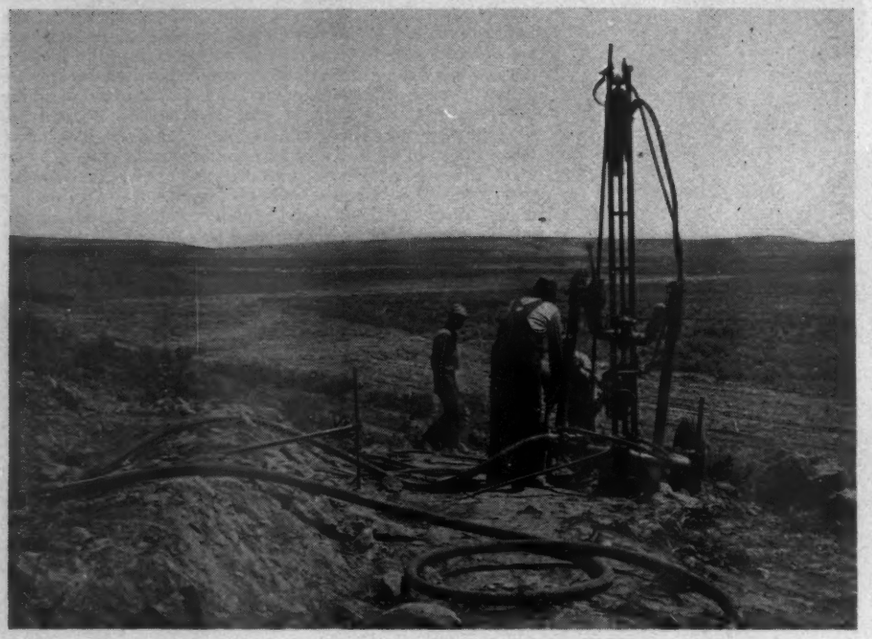
The operator directly below is grinding friction drive rings which are held firmly in position by vacuum chucks designed by the company. Compressed air from the shop line is drawn upon to provide the initial pressure for the hydraulic press at the left which punches single holes on small runs. The picture at the bottom shows the big dynamometer in the laboratory by which finished brakes are tested. The worker is checking the radius of an airplane wheel before it is spun around and pushed against the revolving inertia wheel to simulate a landing. The latter has a rating of 50,000,000 foot-pounds and is driven by an electric motor with a magnetic clutch. The air cylinder that forces the airplane wheel against the flywheel is mounted on top of the dynamometer. Ready for shipment, the boxed products are conveyed to a pneumatic elevator (bottom-left) that hoists them to the loading platform.

compressors. It is stored in a receiver at between 85 and 100 pounds pressure and thence fed to numerous plant outlets and points of use where the pressure is approximately 60 pounds. In addition to the part it plays in the molding and bonding processes, it has typical machine-shop applications, and even reaches into the shipping department where it operates an elevator that lifts the packed boxes to the loading platform. There is a separate compressor in the plant laboratory where brakes, made of a series of bimetal rings, are tested under conditions that are, if anything, more severe than those encountered in actual service.

The dominant feature of the laboratory is a dynamometer that makes it possible to simulate airplane landings and to record the punishment taken by airplane wheels when hitting the ground at speeds as high as 125 miles an hour, which is more than that at which a plane normally comes to earth. It consists mainly of a big inertia wheel, so named because of its resistance to change, and of two uprights from each of which projects on axle connected to a twin air cylinder that is interposed between the uprights. The braking wheel to be tested is mounted on one of the axles and, when spinning at a predetermined speed, is smashed against the revolving flywheel with terrific force.

Electric motors drive the axle and the inertia wheel. When the latter has gained a momentum equivalent to the forward movement of an airplane as it comes in for a landing, air at a pressure of 240 pounds per square inch is admitted to the pneumatic cylinder. This causes the piston to push the rapidly spinning airplane wheel against the flywheel with an impact approximating an actual drop and to hold it there as the brakes are applied. After 25 such "landings" the brake is examined. It's a rigorous test, but the bimetal brakes are said to be equal to it, proving the correctness of the manufacturing methods and of the use of powdered metal.

Columbia Basin Program Started



Bureau of Reclamation Photos

LAUNCHING CANAL WORK
Drillers of the Morrison-Knudsen Construction Company putting down holes in basaltic rock as the first step in excavating a 6½-mile section of the main canal that will distribute water impounded by Grand Coulee Dam to 1,000,000 acres of semiarid land in Washington. The larger picture shows an FM-2 wagon drill for deep-hole drilling. In the other view, Verdon Hollis, who saw fighting on Leyte Island, is using a JB-5 Jackhamer.

THE United States Bureau of Reclamation has recently let some $10,000,000 worth of contracts to initiate works on the huge program of delivering irrigating water from the Columbia River to approximately a million acres of semiarid land in south-central Washington. Other contracts will be awarded as Congress makes additional money available, and by the end of the 1947 fiscal year the commitments scheduled will total $40,000,000. Completion of the program is expected to require ten years.

From the reservoir back of Grand Coulee Dam, finished in 1942, twelve record-size pumps will lift the water 280 feet through 12-foot steel pipes and discharge it into a reservoir and canal system for distribution to the land. Each pump, of which six will be installed initially, will deliver as much water in a day as New York City consumes in the same period. When all twelve are in operation they will handle 7,000,000 gpm. Six of the eighteen 108,000-kw. generators ultimately to be set up in the Grand Coulee power plant will furnish electricity for driving the pumps.

Eons ago, glacial ice dammed the Columbia River near the site of Grand Coulee Dam and diverted it through a new channel. The stream, which was then many times larger than it is now, carved a steep-walled depression or coulee in the surficial rocks that had been deposited there by a flow of lava. When the ice melted, the river returned to its former channel, leaving the coulee—now called Grand Coulee—high and dry on the tableland to the east. By the scheme now underway, it will be converted into an equalizing reservoir by erecting dams at both ends of its 27-mile length. The system will include other dams, the largest of which will be 3 miles long and contain 12,000,000 cubic yards of earth, as well as 488 miles of canals and laterals that will involve the driving of five tunnels and the construction of 66 siphons.

The area to be irrigated measures approximately 50 x 80 miles. It has for the most part a deep, fertile soil, but the annual rainfall totals only 6 to 9 inches. Fortunately, the maximum flow of the Columbia comes during the summer crop-growing months when the snow is melting in the high mountains where its tributaries originate. Thus water that has previously been wasted will be put to beneficial use. Conditions are favorable for raising alfalfa, cereals, potatoes, sugar beets, and vegetables and fruits of many kinds, especially cherries and peaches. The interval between frosts ranges from 135 to 190 days, and the winters are relatively mild.

The land is sparsely inhabited, although 90 percent of it is privately owned. It is appraised at from $5 to $35 an acre, and the Government will purchase it at these conservative values, divide it into family-size farms ranging from 80 to 160 acres each, and resell it to settlers, with preference to ex-servicemen. Purchasers will be required to have at least two years of farming experience and not less than $2000 in cash, or its equivalent in the form of farm machinery, livestock, etc. A charge that will vary according to the productivity of the land and will average $85 per acre will be levied against each tract to defray reclamation costs. Payments will be spread over a 40-year period and, including charges imposed to meet operating and maintenance expenses, will be less than $5 per acre a year.

It is predicted that the area will support an additional 350,000 persons. Of these, probably 80,000 will live on the farms and the remainder in the cities and towns that will be built up. Grand Coulee power will be available at low rates to foster industries. No provision has been made for supplying water for domestic purposes, but this can probably be obtained from wells. Next year, irrigating water will be pumped directly from the Columbia River to approximately 6000 acres near Pasco, Wash., but the larger program will meantime be developed gradually. It is the aim to have 400,000 acres under cultivation by 1950-51.

The dams that are to be placed at the ends of the Grand Coulee will form a basin or artificial lake 27 miles long and up to 4½ miles wide. When filled, the body of water will have a maximum depth of 70 feet. The barrier at the south end is being constructed by Roy L. Blair & Company and James Crick & Sons, both of Spokane, Wash. Their joint bid was $2,771,887. It will be an earth-and-rock-fill structure 2 miles long, and the

time of completion is estimated at 2½ years.

From the south end of the reservoir the water will flow through a tunnel nearly 2 miles long and 23 feet in diameter. A $3,494,420 contract for driving this bore and building 1000 feet of connecting canal has been let to T.E. Connolly, Inc., of San Francisco. A 6½-mile section of the main canal is being excavated by the Morrison-Knudsen Construction Company of Boise, Idaho, under a $619,000 contract awarded last May, and another contract for 5.4 miles was let on June 27 to J.A. Terteling & Sons, Inc., of Boise on a bid of $1,548,060. The canal will be 50 feet wide at the bottom and its sides will taper to a surface width of 112 feet. When it is filled to capacity, the water will be 24 feet deep and will flow at the rate of 9700 cubic feet per second. To eliminate waste through seepage, the canal will be lined with concrete under contracts to be awarded later.

The main canal will extend to Long Lake, another storage unit, to be located 15 miles northeast of Ephrata, Wash. Bids for the construction of the dam that will back up the water are to be opened August 7. It will have a crest length of 1900 feet and a maximum height of 110 feet. Bids were scheduled to be opened on July 25 for the building of Potholes Dam, near Warden, Wash. This earth structure will serve to impound seepage from about one-third of the land to be irrigated, thus recovering it for recirculation and to that extent reducing the load on the pumps at Grand Coulee Dam.

Work on these and other phases of the project that will be underway before summer is over will provide jobs for 2000 men.

Alaskan Port Has a Novel Power Plant

ONE man's loss is another man's gain—so runs an old maxim, and this has been verified recently in the case of a power plant acquired by the thriving town of Anchorage in Alaska that was very much in need of one. Anchorage, which now has a population of approximately 3500 persons, is on the Kenai Peninsula in the Cook Inlet region which has played an increasingly important part first in the construction and subsequently in the operation of the Alaska Railroad. Further, the community is the trade center of the agricultural and mineral industries of the productive Matanuska and Susitna valleys.

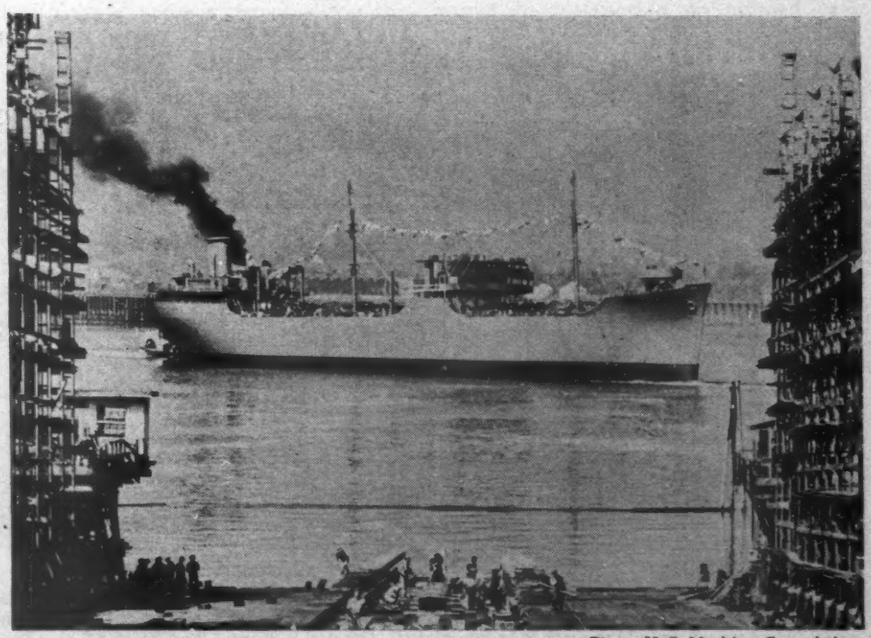
Strong winds and the battering seas of the northeastern section of the Pacific Ocean, plus the determination and courage of hardy seafarers, contributed to the relief of Anchorage through a marine mishap that enabled the government authorities to deliver to that town the power plant housed in the surviving half of a 16,000-ton tanker that had broken in half in the vicinity of the westernmost islands of the Aleutians.

The *S. S. Sackett's Harbor* was built in Portland, Oreg., and delivered to the U.S. Maritime Commission in July of 1943, and thereafter she was kept busy in the war years transporting vitally necessary gasoline. On the first of March of this year, while still in service in the stormy waters contiguous to the Aleutians, she was battling against high seas and a driving gale when her hull broke in two amidships. The bow and stern sections parted company, bearing away with them separate groups of the ship's personnel. The crew members of the powerless bow half were rescued some time later by Navy craft dispatched from neighboring bases notified by wireless of the disaster. The abandoned bow section was then sunk by gunfire to prevent it from becoming a menace to navigation.

Capt. A. S. Morse, the master of the *Sackett's Harbor*, and nine members of the tanker's complement, left the still floating stern to board the *U.S.S. Orlando*, a Navy patrol frigate. The captain then radioed that he and his men would return to their ship and try to work her under her own power to port. That was done, and, crippled as she was, the *Sackett's Harbor* made toward Adak Island in the Andreanof group of the Aleutians at the rate of only 2 knots. Happily, it was not long before the *U.S.S. Sarsi*, a Navy tug, arrived, made fast a line to the wreck, and towed her to harbor. No doubt a damage-control force bolstered up the exposed bulkhead nearest the point of cleavage so that it could withstand the battering seas encountered on the slow journey to port. After reaching Adak, which does not boast a shipyard, it was necessary to decide just what to do with the surviving half of the tanker. What followed is thus explained by an official news release issued by the U.S. Maritime Commission, Washington, D. C.:

"Delegate E. L. Bartlett, of Alaska, requested the Maritime Commission to allow Anchorage the use of the *Sackett's Harbor* engine-containing stern as a temporary or permanent power plant. Coöperation of the Department of the Interior was obtained, and when the Maritime Commission determined it would cost $1,000,000 to fit the stern with a bow section, it was ruled that the tanker remnant was surplus and not a merchant vessel subject to the Ship Sales Act of 1946, and the request was granted. A War Shipping Administration tug was then dispatched to Adak to haul the floating power plant to her dry-land job at Anchorage."

The stern half, after suitable temporary strengthening for the long sea haul to Cook Inlet, something more than 1000 miles to the east, made the trip without mishap and is now safely grounded at Anchorage. The steam turbines of 6000 hp. were undamaged by the storm and, housed in their original position with their boilers and other auxiliaries, will prove a boon to Anchorage, especially under present conditions when such equipment is still hard to get even near the sources of supply.



Photo, U. S. Maritime Commission

S. S. SACKETT'S HARBOR

This and That

German Vacuum Furnaces

A Department of Commerce report based on information brought back by an American investigator describes a German process for melting and pouring metallic alloys under vacuum. At Hanau, this technique was used with beryllium alloys to prevent loss of beryllium, to eliminate gases, and to produce hardenable metals of controlled composition. The plant specialized in alloys for thermocouples, heating units, precision springs, and high-temperature work. Most of them were melted and poured inside vacuum induction furnaces that were pumped for from six to eight hours to reduce the inside pressure to 7 millimeters (0.273 inch) of mercury, the pressure remaining constant during melting and pouring. The crucible used had a tap hole plugged with metal that was melted by an induction coil when the alloy was ready to cast. Casting was done in a water-cooled copper mold.

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Rayon Cord Tires

When rayon is substituted for cotton in the cords of an automobile tire less heat is generated at high speeds, and the cooler running that results increases tire mileage. These facts have been known since 1931, and rayon-cord tires have been made to some extent in the past for trucks and buses, especially where long runs at high speeds were involved. Now, The Goodyear Tire & Rubber Company has started the production of passenger-car tires in sizes of 6.50 and larger that embody a specially developed cord known as Rayotwist. Only a percentage of the output is of this type, and the rayon-cord tires are not identified by any marking. During the war, rayon-cord fabrics were used extensively in military tires to dissipate the abnormally high temperatures generated by the synthetic rubber that was being employed.

★ ★ ★

Vacuum Cranberry Picker

A vacuum-type picker will be used in eastern cranberry-growing areas this fall, according to M. L. Urann, president of Cranberry Canners, Inc. The machine will suck the berries off the bushes at the rate of 250 pounds an hour, or double the hand-picking speed, and will not damage the buds.

★ ★ ★

Peacetime Magnesium Applications

The war greatly accelerated the development of the magnesium industry and our annual production reached a peak of 366,000,000 pounds. Most of the metal went into military equipment, and the industry is now endeavoring to find peacetime uses that will absorb the output of the facilities at hand. Numerous new applications have already been reported to The Magnesium Association.

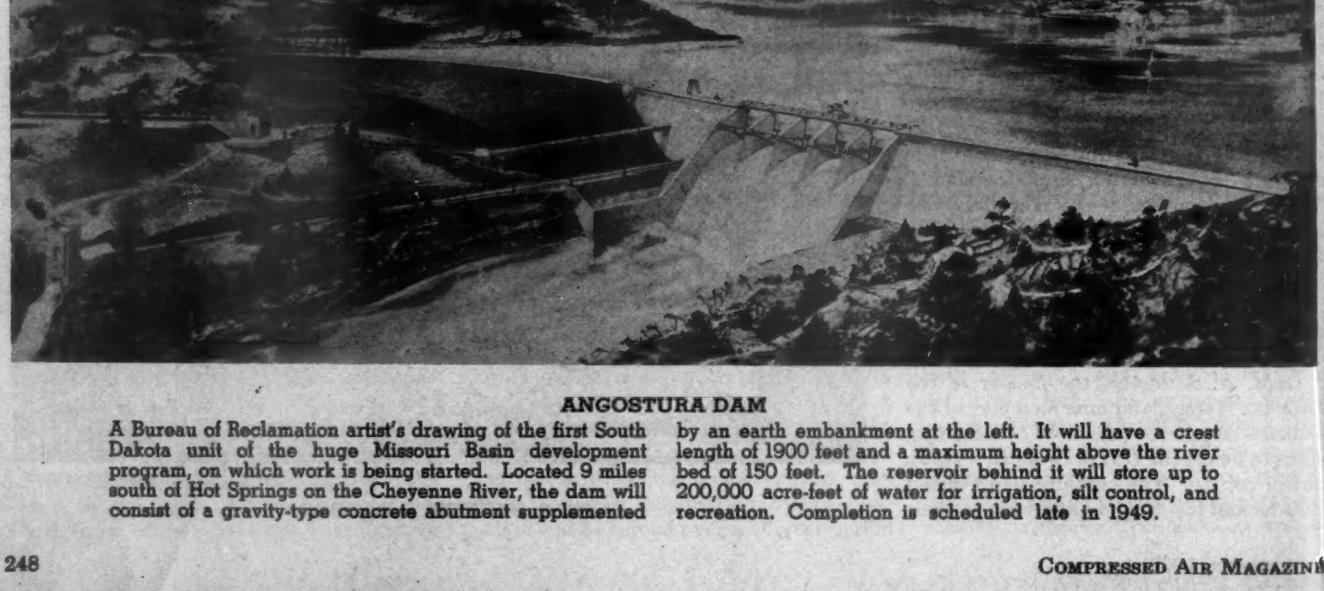
A scaling ladder for firemen has hollow magnesium rungs that are lighter than wood and have corrugated surfaces that provide a firm footing when wet. The rungs are made by Revere Copper & Brass, Inc., by heating a billet of magnesium until it is semiplastic and then extruding it through a die with pressure applied hydraulically. The extruded section is cut into rung lengths. For erecting temporary platforms or docks for loading several freight cars simultaneously at factories, Edward S. Christiansen Company is turning out magnesium boards that weigh only 77 pounds and can be shifted by one man. They are 42x66 inches in size and made of quarter-inch plate reinforced with welded 2-inch "I" sections. They will support a motorized industrial truck and load weighing 1600 pounds.

Pianos that will not warp and develop peculiar vacant sounds at the seashore or in other damp locations are being manufactured by substituting magnesium for wood in the playing mechanism. Several railroads will soon be operating sleeping cars having built-in beds with magnesium frames. They will swing out of a wall recess at the touch of a button. Cars of this type are being constructed by the Budd Company of Philadelphia.

★ ★ ★

Dry Ice Gun

An Illinois manufacturer is reported to be preparing for the production of a rifle that is designed to shoot with carbon-dioxide gas generated by dry ice in the magazine. Pulling the trigger opens a valve to admit gas to the barrel, where it expands to force out the bullet. It is claimed that ½ pound of dry ice produces enough gas for firing 1000 rounds from a .22 caliber



ANGOSTURA DAM

A Bureau of Reclamation artist's drawing of the first South Dakota unit of the huge Missouri Basin development program, on which work is being started. Located 9 miles south of Hot Springs on the Cheyenne River, the dam will consist of a gravity-type concrete abutment supplemented by an earth embankment at the left. It will have a crest length of 1900 feet and a maximum height above the river bed of 150 feet. The reservoir behind it will store up to 200,000 acre-feet of water for irrigation, silt control, and recreation. Completion is scheduled late in 1949.

weapon. At room temperature, the gas is said to develop a pressure of 1200 pounds per square inch; but it is proposed to obtain greater pressures by heating the magazine, thus developing a muzzle velocity comparable to that of conventional rifles. Among the gun's advantages over an ordinary rifle, its inventor, Ray J. Monnet, lists the following: Fewer working parts to get out of order, lighter ammunition (no cartridge case or powder), lower cost of dry ice as compared with powder, and absence of fire hazard ((without ammunition the weapon can be used as a fire extinguisher). Expansion of the gas induces cold, and the rifle can be fired at a rapid rate without overheating. Further, the gas is noncorrosive to gun barrels. By providing a magazine large enough to hold 200 or 300 pounds of dry ice, it is suggested that the idea could be applied to heavy pieces of artillery and would permit them to shoot as rapidly as they could be loaded for a period of nine hours.

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Aiding Stream Aeration

Streams exercise their purifying action because of oxygen in entrained or dissolved air. However, many waterways are so overburdened with sewage and industrial wastes that they do not carry sufficient oxygen to overcome pollution. This can be corrected, according to Prof. Richard G. Tyler of the University of Washington, by introducing additional oxygen into the streams. In a paper delivered before the American Society of Civil Engineers, he told of experiments that he has conducted for the past three summers at Park Falls, Wis., where compressed air pumped into the Flambeau River has increased its oxygen content by approximately 1½ tons a day.

Professor Tyler stated that "While experience indicates that the stream is a more efficient purification plant than presently used artificial methods of treatment, the process is too slow for practical application and stream aeration is now being utilized to supplement the functioning of sewage treatment plants." Further, he said that local conditions have to be studied to determine whether it will be less expensive to construct or expand sewage-treatment facilities than to resort to stream aeration. He suggested that reaeration could be used to advantage to rehabilitate bodies of water where pollution has reduced the dissolved oxygen to a point where reaeration becomes economical and effective; to care for overloads of pollution, either seasonal or permanent, where the existing disposal-plant capacity is being overtaxed; to prevent otherwise necessary and expensive plant expansion to protect a stream from increasing pollution as the result of a growth in population or industrialization; and as a secondary treatment where conditions are such as to make it more economical than present-day methods. Finally, the process could be used jointly by several communities where disposal-plant effluents are overloading the receiving stream.

A DIVER IN THE HIGH ROCKIES

This picture, taken around 1900, shows a deep-sea diver about to descend 1200 feet underground in the Smuggler Durant Mine at Aspen, Colo., to renew the packing in a pump that had been drowned out. It is reported to have been the first time that a diver was employed for work of this kind. Aspen is 1000 miles from the nearest seacoast, and the diver was undoubtedly brought in at considerable expense. The stalled pump was about 65 feet underwater in a drift 45 feet above the shaft bottom. Carrying his life line and equipment, he went down on the cage to the twelfth level, felt his way along the drift, and located the pump solely from directions given him by the mine's crew. As he could stay down only 40 minutes at a time, several trips were necessary to do the repair job. Aspen was then one of the nation's leading silver-producing camps, and the restoration of the pump to service enabled the operators to dewater the workings and led to the extraction of some $2,000,000 worth of ore. The mine is now operated under lease by Herron Brothers, who found the photograph among old records. It is reproduced here through the courtesy of "The Mining Record" of Denver.

★ ★ ★

Plan Andes Bore

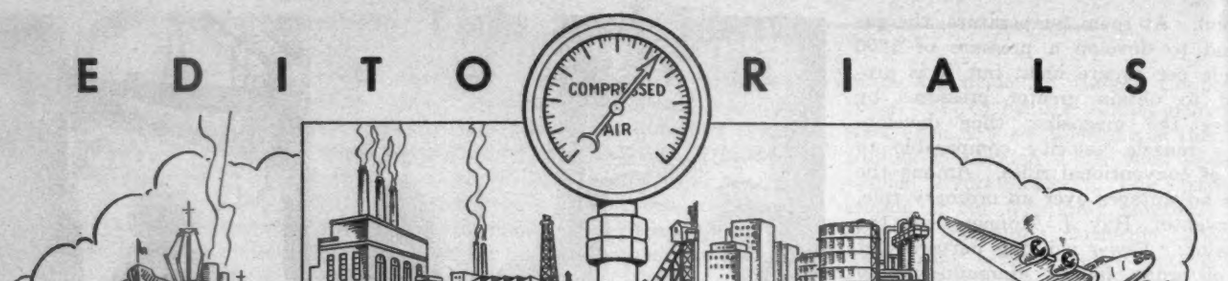
The driving of a 12½-mile transportation tunnel through the Andes Mountains is being considered. It would connect Chile and Argentina and be usable throughout the year, whereas a higher one now in service has to be closed for several months each winter. The bore would have an average altitude of 8465 feet and would be second in length among mountain tunnels—the 13.1-mile Alva B. Adams Tunnel in Colorado being first. An Argentine-Chilean technical commission has made preliminary studies of the project and has submitted three possible schemes for consideration. The most elaborate one provides for a single-track railway tunnel and a 2-way ventilated vehicular tunnel at an estimated cost of $42,500,000. The intermediate proposal is for two single-track railroad tunnels at an estimated expenditure of $21,750,000. The simplest plan calls for a single-track railroad tunnel at an estimated cost of $13,500,000. Under the second and third schemes, motor vehicles would be transported on railroad cars and, as electric locomotives would be used, no artificial ventilation would be required. The Chilean and Argentine approaches would involve additional outlays totaling $4,750,000 and $3,000,000, respectively.

★ ★ ★

Unusual Japanese Compressor

Included among captured Japanese machines that were recently exhibited by the Army Engineer Board at Fort Belvoir, Va., was an air compressor of unique design. Devoid of flywheel, crankshaft, and connecting rods, it consists of a single cylinder with a central combustion chamber. Diesel fuel ignited in the chamber drives two opposed pistons outward simultaneously, thus compressing air at the ends of the cylinder. The unit delivers 3000 cfm. of air at a pressure of 300 pounds and is said to operate with so little vibration that the Japs set it up without a foundation.

EDITORIALS



POSTWAR ROADS

THE nation's postwar roadbuilding program is making good headway, despite shortages of labor, materials, and engineers. As of July, more than $400,000,000 worth of new construction and repairs had been started and it was estimated that before the end of the year the total would reach $715,000,000. It is hoped to increase the volume of work gradually and to reach a pace of $2,000,000,000 per year by 1949. Thereafter, highway experts believe, it should be maintained at that figure or an even higher one for a good many years in order to furnish adequate transportation facilities for the country.

Most of the work now underway consists of Federal Aid projects in which the national and state governments match dollars. The Highway Act of December, 1944, authorized annual appropriations of $500,000,000 for each of the first three postwar years. Approximately 45 percent of the fund will be spent on established Federal Aid highways, 30 percent on a system of inter-regional highways, with connections through and around cities; and 25 percent on Federal Aid roads within urban areas.

Our highway system is the most extensive and best in the world because we operate more automotive vehicles than any other nation. These increased from 8000 in 1900 to 9,232,000 in 1920, and to a peak of 34,460,000 in 1941. The number was reduced during the war years but is now rising again with the resumption of production and authorities predict that there will be 40,000,000 cars by 1950.

All told, we have more than 3,000,000 miles of roads. Primary state highways make up only 11 percent of the total, but carry 72 percent of the traffic. Thus far, only comparatively minor portions of the highways have been adequately paved. Of these, 93,394 miles are surfaced with concrete, 83,748 miles with high-class bituminous mixtures, and 3073 miles with brick. More than 1,500,000 miles are unsurfaced dirt roads, while 1,220,000 miles are surfaced with prepared soils, gravel, or low types of bituminous compositions.

Aside from the obvious benefits of moving people and goods quickly and at low cost, and greater traffic safety, there are several advantages to be derived from good roads and various reasons why a large-scale highway construction program is desirable. In the first place, roadbuilding pays it way. Registration fees for vehicles in the various states and state and federal taxes on gasoline bring in amounts substantially equal to the sums these agencies spend on roadbuilding.

Secondly, roadbuilding, in common with all heavy construction work, is the type of effort that is good for the national economy because it creates employment back of the scenes as well as on the job. During the depression, men were put to work with rakes and shovels and for each one employed on construction there were only 1.7 men required in supporting industries to supply materials and tools. By contrast, five men are needed in the factories for every man on the job under the normal system of building roads with mechanical equipment. The WPA scheme had the effect of stifling industry, whereas the free-enterprise system stimulates industrial activity and makes jobs all the way back along the line.

THE TOOLS OF INDUSTRY

LAST December, Allen W. Rucker of Lexington, Mass., head of a firm of business counselors, made a radio talk that has produced important repercussions. He pointed out that the land, buildings, machinery, and other physical equipment essential to carrying on business and industry have been provided largely by middle-class people. In some cases, they have supplied funds for the operating companies by direct purchases of their securities. In other instances, they have put money in banks, life insurance policies and other channels where it became available for financing commerical ventures of various kinds. He estimated that there are about 50 million of these people, whom he called tool owners because they supply the tools of production and distribution. They saved and invested, he said, because they believed in the profit-and-loss system and were willing to risk their capital under it. He predicted that the postwar wave of strikes, inflation, and shortage of goods would lead these 50 million "forgotten men" to organize to protect their investments and to insure continuation of the form of government and the economic scheme that have made the nation a world leader.

Some of his listeners took it upon themselves to obtain and distribute 15,000 copies of his remarks and his ideas were gradually spread about the country. People began to ask Mr. Rucker to take the lead in forming such an organization as he mentioned and he did so, calling it the Tool Owners Union. Members enrolled, paid membership fees, and made greater publicity of the movement possible. The things the group stands for were set forth in a full-page advertisement in the Lexington *Minute Man*.

"Every workman," it was stated, "knows that the tools he uses are the source of his livelihood. Without a taxicab, the taxi driver would be no more than a ricksha boy; without the boring machine, the hydraulic press, or the turret lathe, the machinist would be no more than a day laborer at a day laborer's scale of wages. Tools are always wearing out or becoming obsolete and must be replaced. If they are not replaced, no power on earth can maintain production enough to prevent a real drop in the earnings of working people, regardless of wage rates.

"There is just one source of these tools —the savings of some 50 million thrifty Americans. These tool owners accumulate savings from what are erroneously called business profits. The right name for profits is 'payments for the use of tools.' To obtain the new tools so urgently needed, 50 million thrifty Americans must be safeguarded in their right to receive competitive payments for the use of their tools. To deny or seriously to infringe that right is to destroy the incentive to thrift, and with it, the source of funds necessary to renew and increase the tools of production."

Correspondence

CANADIAN MAGNESIUM

EDITOR:

I was interested by the article in your May issue dealing with certain electrometallurgical developments in Eastern Canada, and especially that portion relating to magnesium production in the Province of Ontario. In view of the part I played in the establishment and development of magnesium production there, I would like to draw your attention to certain well established facts.

The history of magnesium production in Canada dates from the years before the war, when, as a result of certain experimental work undertaken at the National Research Council in Ottawa, Dr. L. Pidgeon published a report stating that as far as could be seen it was impossible to produce magnesium metal by distillation from metal apparatus. In May, 1940, a copy of this report was handed for criticism to me as Consulting Metallurgist to the British Government authorities in Canada, and owing to the urgent demand for this metal for war and other purposes, the then Director-General of the British Supply Board in Ottawa and New York, in consultation with the British Treasury Representative, who was vitally interested in trying to establish production of magnesium in Canada, agreed at my suggestion that the National Research Council should be given full information concerning a certain long-established English process involving distillation from metal apparatus and using calcium carbide as the reducing agent for magnesiferous raw materials.

Details of the plant used, as well as of the operating conditions, which are as defined in your article for the Canadian process, were accordingly communicated verbally and officially to those at the National Research Council who had been engaged on the pre-war experimental work, and your article accordingly now makes it clear that in establishing production of this metal in Canada, the general principles and methods of the original English process have been retained but with certain modifications. These modifications would appear to be:

(a) The use of ferrosilicon in place of other reducing agents.
(b) The use of horizontal retorts instead of vertical, the possibilities of which were made known to the National Research Council, and
(c) The use of electric heating in preference to other suitable forms of heating.

In this connection it may be observed that the use of ferrosilicon as a reducing agent was known in prewar days to the company operating the distillation process in England, and that its employment for this purpose has been mentioned in the patent literature, and notably in American patent literature, since about 1916. As to the use of horizontal retorts, many designs for both batch-type and continuous operation have been evolved and patented in the past, and as regards the use of electric heating, this is naturally a question largely of local convenience.

It would accordingly appear that any patents covering the process mentioned in your article should refer only to certain forms of apparatus used, which is a matter of considerable importance in view of later English developments, such as that described in British Patent No. 562,108 and its American and Canadian counterparts, when issued, by which the distillation process for the production of magnesium metal may be developed on a fully continuous basis, with many consequent benefits as regards both output and costs. It is accordingly my hope that the publication of these additional facts will prove of interest to your readers in completing the historical and technical details already made available on this subject.

W. F. CHUBB

128 Dora Road,
Wimbledon Park,
London, S.W.19.

ERRORS IN MARCH ISSUE

EDITOR:

The March 1946 issue of COMPRESSED AIR MAGAZINE is well worth keeping for its historical information concerning the development of the use of compressed air. There are, however, two erroneous statements that I would call to your attention. In the second column of page 66 in the article headed *Development of the Air Compressor*, there is a paragraph commencing with the sentence:

"There was comparatively little advance in the sciences between the beginning of the Christian era and the time of Roger Bacon (1561-1626)."

The dates given are not correct. Roger Bacon, a Franciscan monk, lived from 1214 to 1294. He was a man of science who was decades ahead of his time and who, according to history, was jailed for sorcery and witchcraft. The dates given in the article represent the life span of Francis Bacon. He was a statesman and man of letters who lived in the time of Queen Elizabeth.

On page 70 of the same article, the last sentence of the second paragraph in the first column reads:

"A vacuum pump is essentially an air compressor acting in reverse."

This statement is erroneous and misleading, although it is very often made. The sooner it can be squelched, however, the sooner there will be a proper understanding of just what a vacuum pump really is. In this connection, I quote from a paper *Compressors and Accessories* that I have read to our University of Toronto students and two or three other student organizations:

"It should be noted that a vacuum pump is nothing more than an air compressor. Some people say it is an air compressor in reverse. That is not true, as one can readily see if one keeps in mind that all compressor calculations for horsepower are worked from absolute pressures and not gauge pressures. Both the vacuum pump and the air compressor take in air or gas at some lower pressure and compress it to some higher pressure. The vacuum pump works in the realm of pressures below atmospheric. The compressor works in pressures above atmospheric. The vacuum pump usually has a variable intake pressure and a constant discharge pressure, generally atmospheric. The air compressor usually has a constant intake pressure, generally atmospheric, and a variable discharge pressure, up to the pressure desired in the system."

You will see from the foregoing that the assumption that a vacuum pump is an air compressor in reverse creates a mental outlook that prevents a proper understanding of how a vacuum pump works.

Montreal, Canada — C. N. DANKS

"I'm sure I could sell your stuff - - I've always been a high-pressure salesman."

Pneumatic Briefs

The Bureau of Census, U. S. Department of Commerce, reports that shipments of rock drills to the construction industry aggregated 1532 units valued at $515,690 in the third quarter of 1945 and 1504 units valued at $415,054 in the fourth quarter. Unfilled orders at the year's end totaled 1372 units valued at $383,665.

The California Walnut Growers Association processes as many as 50 carloads of nuts a day. After being cracked, they are fed into a stream of air whose velocity is maintained constant by an electronic control. The light shells are carried away by the air current, while the heavier nut meats drop onto a conveyor.

Twenty-five thousand tons of air an hour will be moved to ventilate the Brooklyn-Battery vehicular tunnel now being driven under the East River in New York Harbor. Fifty-three large fans will be used to change the air in the bore every 90 seconds. Twenty-seven of them will blow in fresh air, which will emerge through openings near the floor, and the 26 others will exhaust vitiated air through vents in the ceiling.

A British report on the Hermann Goering Steelworks in Germany states that it had been planned to build 32 blast furnaces in four groups of eight units each. One complete group and two furnaces for another had been constructed when the war ended. The furnaces are of two sizes, with respective daily capacities of 450 and 550 tons of pig iron from beneficiated ores containing 42 percent of iron. Blast air was supplied at a temperature of 1200°F. and a pressure of 15 pounds. The smaller units each used approximately 41,000 cfm., and the larger ones from 47,000 to 59,000 cfm. Among the steel-making equipment are six basic Bessemer converters, reportedly of record size. Each has an average capacity of 50 tons and a maximum of 63 tons.

Inner Soles Bathe Feet with Air

A WASHABLE shoe ventilator that insures circulation of air around the foot with every step taken and that was worn by G.I.'s in many war theaters has been made available for civilian use. Called the Vent-O-Sole, it is really a pedal air compressor. Of plastic-mesh construction, the weight of the body compacts it at each step, compressing the air within its openings and forcing it throughout the shoe. As the foot is lifted, the ventilator expands, and air is drawn in through the opening around the top of the shoe.

This inner-sole ventilator was developed at the request of the Quartermaster General's office to protect soldiers from the progressive worsening of foot troubles that plagued them when field conditions made it impossible to observe the usual precautions. It was known in the service as "Innersoles Plastic, Ventilating Type, Fused," and was adopted as Government Issue. The British ordered 6,000,000 pairs after tests had shown that it relieved foot troubles in every climate. The circulating air evaporates moisture and also expels the moisture-laden air. Consequently, feet stay warm and dry in winter and cool and dry in summer. Further, socks stay clean longer, creating a combination of conditions that physicians have long recognized as conducive to healthy feet.

For the time being, the Vent-O-Sole is being produced in limited quantities for issue by safety, personnel, and medical departments of industrial concerns to workmen under treatment for athlete's foot, blisters, etc. When the supply becomes more plentiful, the inner sole is expected to give foot health and comfort to farmers, sportsmen, store employees, and others who spend much time on their feet.

Silver-Plating and Polishing in the Same Bath

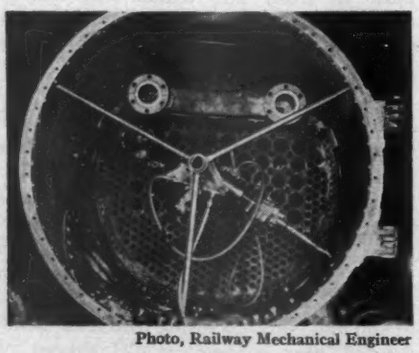
FROM two separate sources comes the announcement of the practicability of polishing silver by the relatively new electrolytic process that has so far been used mainly to give stainless steel its bright finish. Development of the new field of application, according to reports, has come about as the result of accidental discoveries in the plant of Oneida, Ltd., manufacturers of silverware, and in the Westinghouse Research Laboratories. In the former, it was observed that some electrodes in a silver bath occasionally appeared as though they had been buffed; and in the latter, an unpolished silver-plated wire, that had been utilized by chance to suspend a phosphor-bronze part that was being cleaned electrolytically, was found, upon removal from the bath, to have a high luster. Those were the clues that pointed the way to the polishing of silver by what has been described as "electroplating in reverse."

By the new method the articles are plated and polished simultaneously, thus eliminating one step in the operations. They are immersed in much the same kind of alkaline-cyanide solution that is generally used; but after they have been electroplated the current is reversed. The action thus induced removes a small amount of silver from the plated object and gives it the desired smooth, mirror-like finish. That metal is deposited in the bath, from which it is reclaimed from time to time, whereas in manual or mechanical buffing it is rubbed off and lost.

Electropolishing is now used by both Oneida and Westinghouse in finishing silver-plated tableware and silvered contactors, microwave components, and switchgear and radar parts, respectively. The former developed its process to the present practical stage in coöperation with Arthur D. Little, Inc. This organization of chemists and engineers reports that the method does not necessitate any change in electroplating equipment, that it lends itself to automatic operation, that it reaches deep recesses inaccessible to buffing wheels, and that the time required to do the work is about five to twenty seconds, depending upon the condition of the surface.

Railroad Shop Solves a Drilling Problem

SET-UPS that simplify work are always worth passing along for the benefit of the fellow who has a similar job to do. J. R. Phelps, machine-shop foreman at San Bernardino, Calif., for the Atchison, Topeka & Santa Fe Railroad, is of the same mind, for he has publicized equipment developed and used in that shop for drilling and spot-facing holes in smokeboxes and saddles of locomotives when applying new cylinders. The holes must be drilled radially from the center of the smokebox, and this is done by an air-operated tool the motor of which is so mounted on a shaft that it can be rotated freely. The shaft, of 4-inch cold-rolled tubing 7½ inches long, is supported at the open end of the smokebox by three 1¼-inch pipe braces spaced 120° apart, and at the flue-sheet end by a bracket with a $3^{3}/_{16}$-inch cylindrical lug that fits inside the tubing.



Photo, Railway Mechanical Engineer

SPECIAL AIR-DRILL MOUNTING

With this set-up, a worker can keep his tool in radial position in smokeboxes and saddles and drill 78 holes 1¼ inches in diameter by 4¼ inches long, spot-face them, ream them, and apply the bolts and nuts in a maximum of twenty hours. The bolts are driven by a long-stroke air hammer and the nuts are tightened at the same time by an impact wrench. The air motor is controlled by a pneumatic cylinder.

In place of the customary hand feed screw, the air motor is controlled by a 4-inch pneumatic cylinder with an 8-inch stroke that is suspended from the central shaft by a clamp, to which it is welded. Air admitted to either end of the cylinder by a 3-way valve applies pressure to the motor in two directions: outward for drilling and inward for spot-facing. For the latter work the motor is connected to the cylinder piston rod by a yoke and a special drill socket with a collar to take the upward thrust. A reducing valve in the air-supply line controls the cylinder pressure.

FOR ROUGH SERVICE

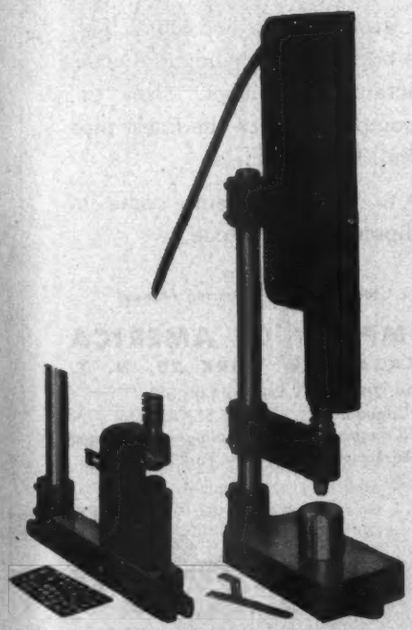
The pneumatic tire shown here is of a type used on mine shuttle cars and is provided with a Shinguard designed by The Goodyear Tire & Rubber Company. The shield is made of ⅜-inch steel and is held in place by lock rings. There is ample space between it and the tire to allow for normal flexing without chafing of the sidewall, and the diameter of the disk is sufficient to protect that area from cutting and snagging, fruitful sources of tire failure in collieries where standing pillars with sharp projections offer obstructions to shuttle cars.

Industrial Notes

For heavy-duty service such as logging and strip-mining, Goodyear is planning the production of a tire in which fine wire of high tensile strength is placed between layers of rubber and cemented to them.

There's a new petroleum product on the market that serves as a desiccant. It is in the form of spherical beads of uniform size and shape and adsorbs up to 40 percent moisture. When completely saturated it can be regenerated by subjecting it to a temperature of 300°F. Among the potential applications listed is industrial packaging, and it can also be used to advantage in ships' holds, warehouses, and air-conditioning systems it is claimed.

Weighing only 27 pounds, the new Impact Air Hammer announced by Mead Specialties Company can be placed on a shelf in a tool room ready for quick mounting. For small-scale punching jobs, units may be set up in groups, each controlled by an operator, but for putting multiple holes in large-size metal sheets may be bolted down on all four sides of a worktable provided with rows of tapped holes and as much as 8x40 feet in size. Any desired number of holes can thus be pierced at one time, it is claimed, and in any pattern. For work of this kind the hammer is usually used in conjunction with a standard punching unit such as a Wales-Strippit and can put a ⅜-inch hole in .065 cold-rolled steel when using air at 100 pounds pressure per square inch. With suitable attachments the machine may be utilized for upsetting rivets, blanking out soft materials with knife dies, light coining and forging operations, stamping identifying marks on metals and synthetic materials, etc. Ram is of the single-acting type and delivers blows ranging from a few ounces to 4000 pounds pressure. Air consumption at full stroke amounts to 5 cubic inches per cycle. Hammers are obtainable with bases 1¾, 4½, and 10 inches wide.



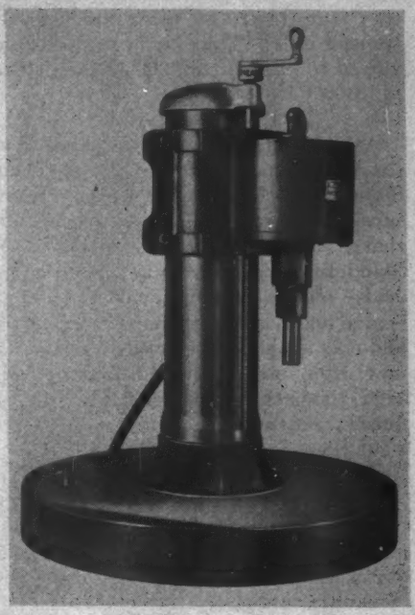
PUNCHING AND UPSETTING

Set-up at the left shows air hammer equipped with a Wales-Strippit punch and narrow base for multiple piercing operations. Because of limited over-all width of unit, holes can be punched on 1¾-inch centers. For other work such as upsetting rivets a tool holder is mounted on the column (right). For single operations of this kind permitting the use of a heavy table the base is of the standard 4½-inch type.

Such a simple thing as suspending an iron chain down the middle of a cyclone has been the means by which a crushing plant has overcome an operating difficulty. Despite the fact that the cyclone has steeply sloping sides, the pulverized material did not flow out freely—the discharge was lumpy and intermittent. The chain is made up of ¼-inch links, and at 8-inch intervals throughout the lower half are welded pieces of iron ¼ inch by 1½ inches in size. When hanging vertically, it extends about 2 feet below the outlet to allow for flexing. The whirling air in the cyclone moves the chain around slowly, causing it to scrape against the sides converging upon the outlet and to keep them free of accumulations.

To stop cold-water pipes from sweating and dripping through condensation under warm, humid conditions, Mystik Adhesive Products is offering an insulation named Self-Stik Dri-Pipe. It consists of an inner layer of pliable, water-repellant material backed by a moistureproof resinous-coated cloth that overlaps the insulation and has adhesive edges. Application is effected by fastening one edge to the pipe, bringing the material around and well over that edge, and then sealing the sheath. The insulation comes in one width for ½ and ¾-inch pipes, but can be used for larger ones by joining as many widths as may be required to cover them completely.

Mead Specialties Company has announced a pneumatic Column Press that is said to obviate the use of a number of air presses in the case of assemblies that call for a succession of operations each involving a different fixture. The device is designed especially for small- to moderate-scale runs where it is desirable to leave fixtures permanently mounted. The Column Press is simply swung over each, in turn, raised or lowered to the correct height by means of a screw, and locked in place with two drawbolts. To speed up production, it is desirable that the several



fixtures be complete so that no dies, punches, or other tools have to be attached to the ram—in other words, that the pressure of the ram itself will suffice to do the work. The unit has an over-all height, excluding handle, of 24¾ inches; maximum ram clearance above table of 11 inches; maximum depth of throat of 4¾ inches; a stroke of 3 inches; and delivers a pressure of 3000 pounds on 110-pound line pressure.

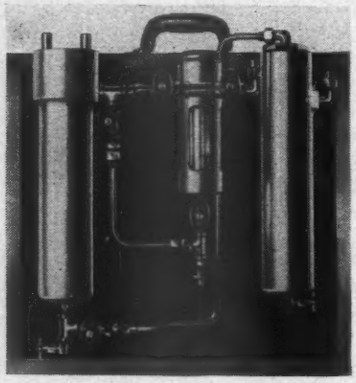
Continental Air Filters, Inc., has been organized in Louisville, Ky., and is building a factory there to manufacture air filters for compressors, diesel and gas engines, and other industrial equipment. The firm's president is Wm. K. Gregory, who served as an executive of the American Air Filter Company for 22 years. Directors, in addition to Mr. Gregory, are: Fred D. Durham, president of C. Lee Cook Manufacturing Company; Raymond Deateale, vice-president of Glenmore Distilleries Company; and J. F. Shouse of J. F. Shouse & Company.

A new type of heat exchanger that makes use of a moving column of heated refractory pebbles to heat gases has been developed by The Babcock & Wilcox Company. The apparatus consists of two cylindrical chambers placed one above the other and connected by a smaller throat section. Starting at the top, the pebbles flow through it by gravity at a controlled rate and are then elevated for another trip. Combustion products from a fire directed into the bottom of the upper chamber pass upward through the pebbles and heat them, while the gas or steam to be heated is introduced at the bottom of the lower chamber, flows upward through the hot pebbles, and is

drawn off at the top of that chamber. It is claimed that the unit will heat gases and steam to higher temperatures than they can reach in conventional heat-transfer units. Thus far, it has been employed to heat air to 2300°F., and steam to 1800°F.

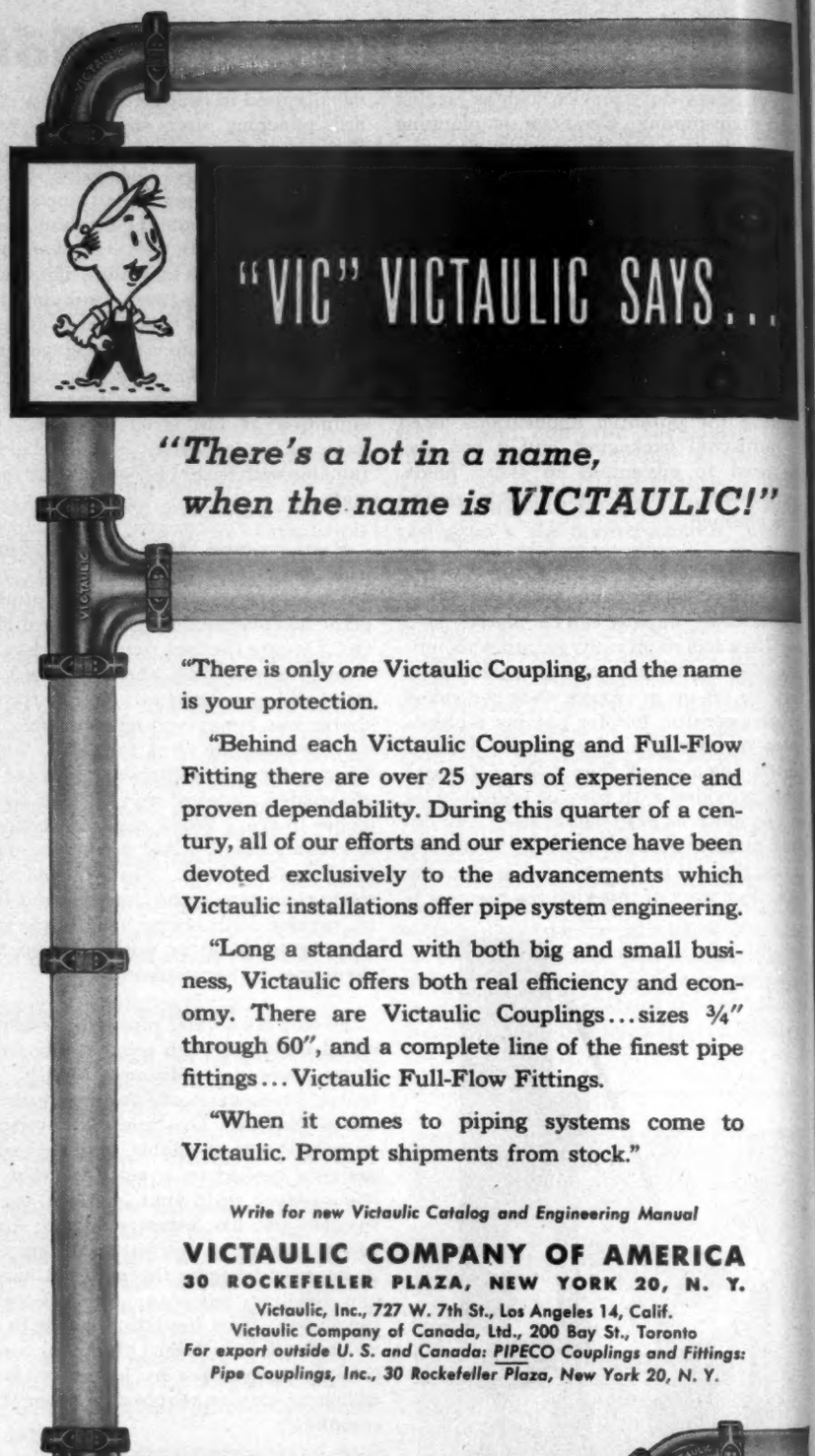
Among the new products discussed at the recent annual technical meeting of the Standard Oil Company (Indiana) and its subsidiaries was a metal-plating medium that is being commercially developed by Standard. According to its chemists, the acids—alkane sulphonic acids, to be exact—give highly soluble salts of most metals and may supplant the poisonous cyanides now often used. In addition to being safer, the bath is said to produce brighter finishes and to do the work from two to eight times faster.

Developed during the war for the armed forces by the Russell R. Gannon Company, the function of the D-10 Dehydrator shown here was to control the moisture content, relative humidity, and dew point of air and other gases in the transmission lines of radar gear in B-29



bombers. The unit is now generally available and has many applications, including the dehydration of lines carrying compressed air at pressures up to 2000 pounds per square inch. It is said to have a moisture pickup capacity of 50 grams of water while maintaining a dew point of 90° below zero Fahrenheit, and can be equipped with a dew-point color-change indicator to insure proper working conditions.

Three cutting-oil bases of varying compositions for different machining operations are offered by the National Oil Products Company. Nopco 1009-A is for straight cutting in ferrous metal and is said to give a smooth finish and noncorrosive surface. It contains 15 percent sulphur in chemical combination and active form and is used after dilution with low-viscosity mineral oil. For work such as turning, grinding, broaching, and polishing that requires rapid dissipation of frictional heat, 2009-A is recommended.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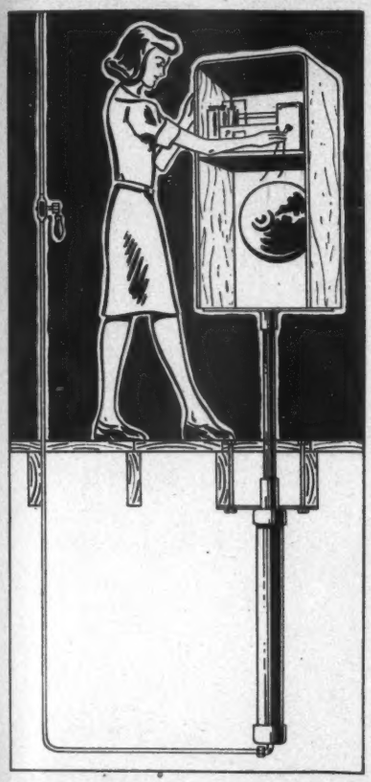
It blends with water to provide a stable emulsion with strong detergent qualities. The third coolant—1009-C—contains sulphur and chlorine and is intended for machining steel, brass, and copper. It is given the required viscosity by diluent petroleum oil and is odorless and free from tarry matter.

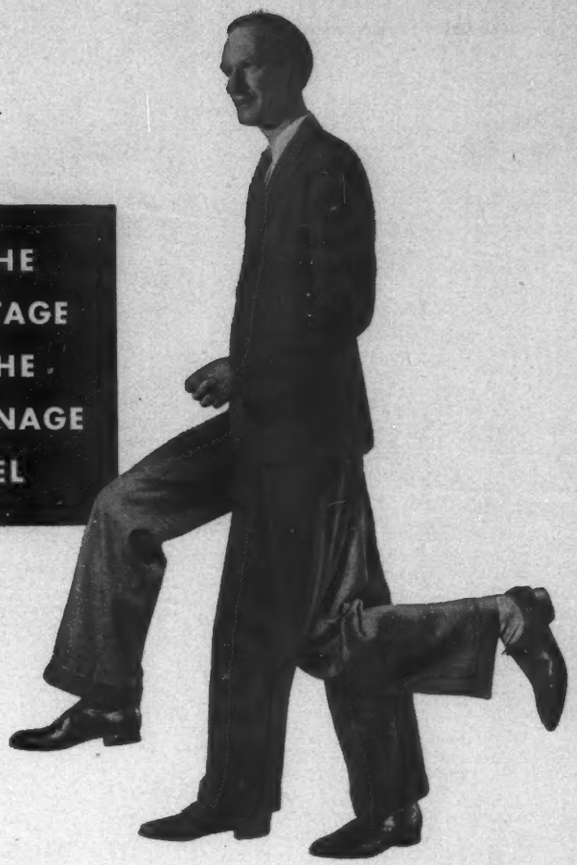
It has been announced by the Director of the National Bureau of Standards that two members of its Electrochemistry Section have developed a process for nickel-plating steel without the need of electric current. Deposition is effected by chemical reduction of a nickel-salt solution with hypophosphites. Because of the cost of the method it will not find general application, but it may have special uses such as treating articles that cannot be satisfactorily electroplated.



LIFTS, LOWERS, AND TURNS

These three features are combined in a table that is designed to facilitate a wide variety of operations such as packaging, assembling, trimming, spray-painting, etc. It obviates bending and lifting and enables work to be placed so it will always receive the best possible light and at a level at which the operator can do it with the least fatigue. Known as the Samson, Jr., Pneumatic Lift, the table has a diameter of 18 inches and is attached to the piston of a vertical, single-acting cylinder mounted below floor level. With air at 60, 70, or 80 pounds pressure it has a carrying capacity of 450, 525, and 600 pounds, respectively. Control is effected either by a hand or a foot valve, which can be adjusted to raise the table to any desired height. When air is exhausted from the cylinder, table descends by gravity.

TWICE THE PIPE FOOTAGE FROM THE SAME TONNAGE OF STEEL



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Industrial Literature

Complete instructions for wire stretching and stringing are presented concisely in a bulletin issued by W. C. Dillon & Company, 5410 W. Harrison St., Chicago 44, Ill.

Instruments and controls for process industries are described and illustrated in a new bulletin, No. 17, issued by Bailey Meter Company, Cleveland 10, Ohio. Application data are given and typical control systems of single- and multiple-element types are illustrated.

A tool for quickly opening flanges on pipe lines and most flanged surfaces for renewal of gaskets has been developed by T. G. Persson, Bloomfield, N. J. Called the "Flange Jack," it replaces the hammer-and-chisel method and eliminates many of its disadvantages. Literature is available upon request.

Industrial knives made of high-alloy steel backed by a suitable softer steel are in increasing demand in the wood pulp, paper, wood working, sheet metal, and textile industries. For these purposes, the Jessop Steel Company, Washington, Pa., makes composite steels by the Armstrong method. They are described in a new bulletin, *Jessop Type "R" Composite Tool Steels.*

The Homestead Valve Manufacturing Company, Inc., Coraopolis, Pa., has issued a circular describing a new model of its Hypressure Jenny steam cleaner. Produced as a portable, compact unit on steel wheels, this equipment is used for cleaning all types of machinery and building exteriors, and also for sterilizing and disinfecting service on dairy and poultry farms.

The Alloy Metal Wire Company, Inc., Prospect Park, Pa., offers a new catalogue, *D-2*, giving general information and engineering data on various high-nickel-content alloys that it produces in the form of wire, strip, or rod. The metals covered are nickel, Inconel, "Z" nickel, "L" nickel, and Monel, including specialized varieties suitable for being machined and heat treated. All of these alloys are employed in the arts and industries where strength and resistance to corrosion are required.

It has been established that vibration of machines not only reduces their service life but also adversely affects the efficiency and health of people around them, even to the point of causing digestive disturbances. Various anti-vibration devices are now available for use on machine mountings, among them being bonded rubber and metal shapes that are essentially rubber springs or cushions. The B. F. Goodrich Company, Akron, Ohio, produces them under the name of "Vibro-Insulators" and has issued a new booklet describing them.

A revised edition of a 36-page bulletin on Type 40 air compressors has been issued by Ingersoll-Rand Company, 11 Broadway, New York 4, N.Y. The best known model of this machine, called the "Motorcompressor," combines a compressor and an electric motor driver in one compact unit. Other models are driven by a flexible coupling or by V-belts. Standard air-cooled machines are available in seven sizes, ranging from 79 to 515 cfm. piston displacement at 100 pounds discharge pressure. New high-pressure units are listed for the first time. Air-cooled models are offered for 200 pounds pressure and water-cooled machines for 500 and 600 pounds pressure. The bulletin is designated as *Form* 3166-C.